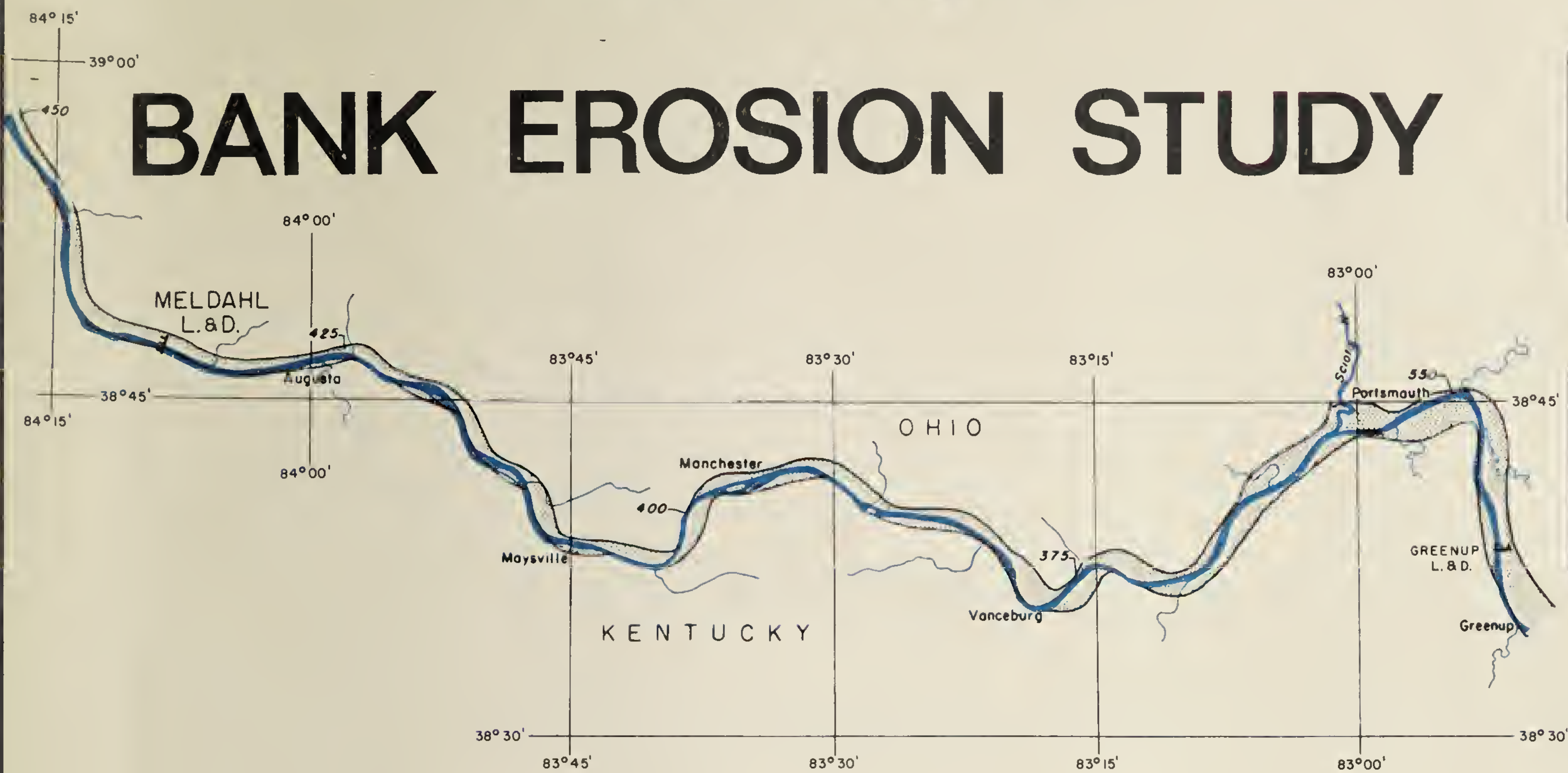
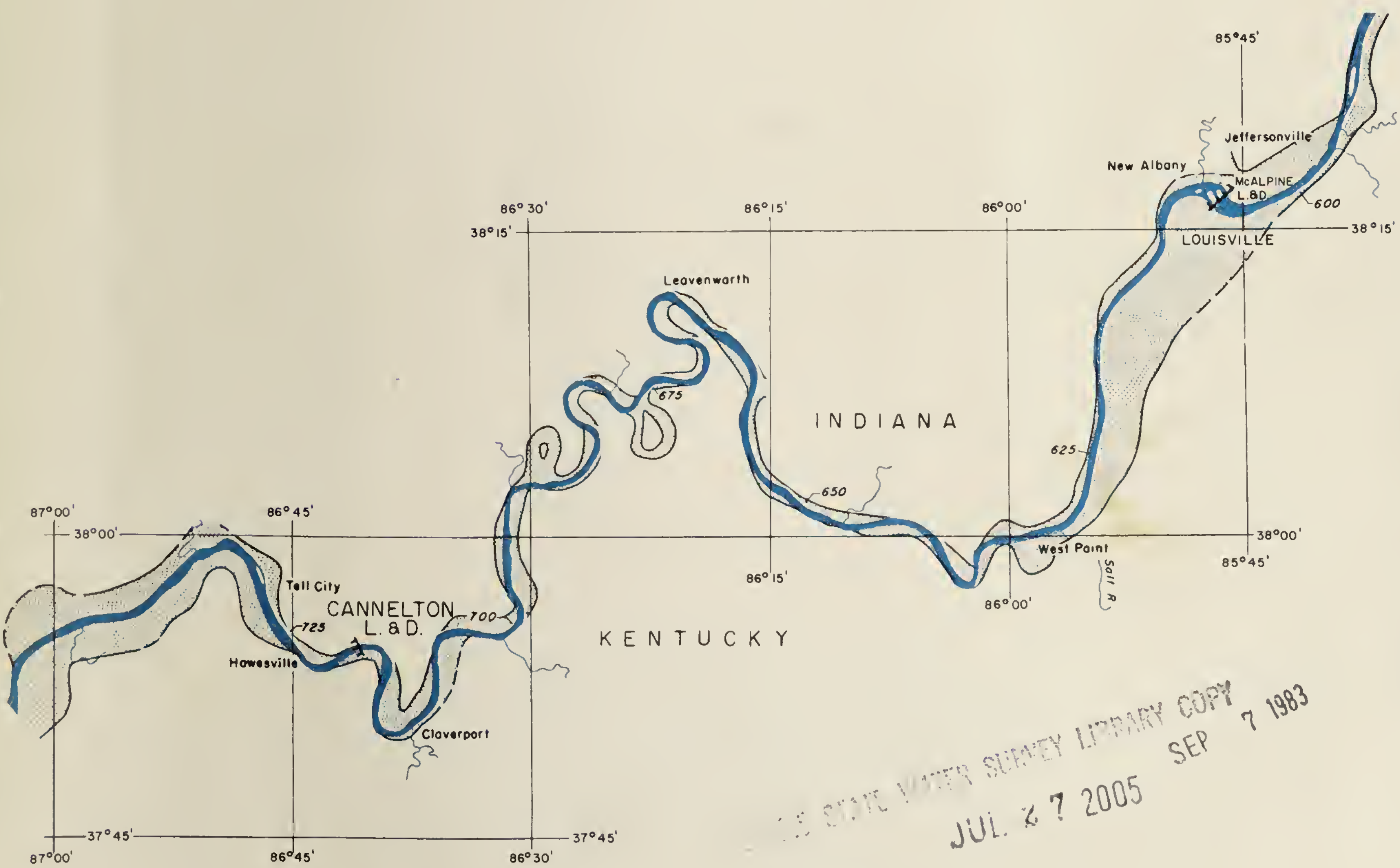
OHIO RIVER

BANK EROSION STUDY





U.S. ARMY ENGINEER DIVISION, OHIO RIVER

CINCINNATI, OHIO **JULY 1977**

DATE DUE

DEPARTMENT OF THE ARMY
OHIO RIVER DIVISION, CORPS OF ENGINEERS
P O BOX 1159
CINCINNATI, OHIO 45201

IN REPLY REFER TO

ORDDE 8 July 1977

MEMORANDUM FOR: MG CHARLES I. McGINNIS, Director of Civil Works

SUBJECT: Litigation on Streambank Erosion

1. I had previously reported to General Graves the status of our erosion study efforts in my 14 June 1977 memorandum. Briefly summarizing--the memo covered the background, what has been done, and what remained to be done to complete the report and prepare for trial.

2. On 27-28 June a major milestone was successfully completed. The draft report was reviewed in detail by the steering group, working group, consultants, and OCE representatives. I certainly appreciated the assistance and input provided by Messrs. Homer Willis, Jake Lankhorst, and Sam Powell. I believe the review was comprehensive and of sufficient scope to go final on the study report. The changes, additions, clarifications, and corrections have been made and I am furnishing copies of the study report for your advance information and review. The report will be made available to everyone, including the litigants, and I intend to make the report available on 15 July 1977 for general distribution.

3. Concurrent with these advance copies to you, I am also providing copies to the steering group, consultants, and the Department of Justice (through Manny Seltzer's office). After 15 July a more complete distribution will be made and I will keep you advised.

4. We are currently working out details to try to meet with the consultants and Department of Justice probably during the week of 25 July in order to discuss trial preparation and prioritize the items deemed necessary by the Department of Justice.

1 Encl (trip)
as

E. R. HEIBERG III
Brigadier General, USA
Division Engineer

CF:
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OHIO RIVER

BANK EROSION STUDY

Prepared by

OHIO RIVER DIVISION FIELD STUDY GROUP

Under the Direction of

THE DIVISION ENGINEER'S STEERING COMMITTEE

At

LOUISVILLE, KENTUCKY

8 July 1977

FOREWORD

As this report brings out, there are many complex causes of bank erosion on the Ohio River. Much the same is true of the entire system of rivers across the globe. Every river, indeed every stretch of river, has provided a challenge to mankind ever since we decided to put our works along the banks and establish property claims along the rivers. The Ohio River has a history of eroding banks that long predates mankind's ventures within the valley--well back into geological time.

The Corps of Engineers, since the early 19th century, has been the chief national agent for river improvements. Many other non-federal agencies and private enterprise directly benefit from the Nation's river system--commerce, industry, food, and pleasure. Yet the Corps is today a major "actor" along these rivers. We plan, design, construct, maintain, and operate the immense navigation structures which (through three generations of design and through nearly a century) have provided the citizens of the Ohio Valley virtually 100 percent unlimited utilization of the Ohio River. We also plan, design, construct, maintain, and operate the vast bulk of multipurpose reservoirs within the valley which, over four decades, have reduced immeasurably the damages from widespread floods. Under our regulatory responsibilities, we must assess environmental and other considerations before allowing structures to be built or certain other activities to occur in or along the rivers and wetlands of the United States. These three activities, we feel, have brought stability not before enjoyed along the Ohio River and most of its tributaries, and also provide benefits extending to Minneapolis, Chicago, New Orleans, Tampa, and even overseas. In other words, mankind's activities affecting the Nation's rivers are carried forward in a sensible, orderly way far beyond the more limited "public interest" understanding of earlier generations. Of these contributions, we in the Corps of Engineers are proud.

Yet there is much we do not know about rivers. Much of the details of streambank erosion falls within this area. Perhaps this stems from the complexity of the phenomenon. Perhaps it is because Valley residents expected erosion to occur back in those days when navigation dams were smaller, forming shallower pools, and were not the mammoth structures they are today. Perhaps it is because our parents and <u>their</u> parents were well aware of immense riverbank damage attendant to flooding . . . a way of life for Valley residents prior to the '40's, rather than the comparative rarity a main stem flood is today.

Concerned citizens have brought forward the subject of bank erosion causation through litigation alleging federal responsibility for erosion of their riverbank properties. A concerned United States Congress has provided for streambank erosion demonstration projects now going forward

at a number of sites throughout the Nation under supervision of the Corps, and many of these sites are in the Ohio Valley. The Corps for years has attempted to prevent erosion in the vicinity of its structures, generally with good success, but not without failures. All these factors led to my decision to assemble the study group under Bill Browne of my staff, with the mission of initiating the study and providing this report. With the help of consultants and senior experts on my staff and from the staffs of district engineers on the Ohio River, I have assured myself that this study kept its aim on both the immediate challenge of providing facts for current litigation, and the more general challenge of learning more about streambank erosion throughout the Ohio River length. I believe the report has hit these two marks. We will continue to assemble and interpret new information as it becomes available . . . this report is a beginning.

I caution the reader on one major point. The areas we focus on are 22 sites where Federally-caused erosion is alleged, . . . so these sites are hardly representative. There are perhaps as many accretion sites as erosion sites, and sites which are relatively stable.

On behalf of the Chief of Engineers, I thank the study group members under Bill Browne for the hard work they've done. I must also thank many wives and families, for many of the members and others did their work far from home. I also thank the many "bosses" who lost the services of this highly talented group for up to ten weeks. My appreciation also goes to the many consultants and consulting agencies, noted in the report, who provided their valuable advice. I also thank my boss, the Chief of Engineers, for sending members of his staff to provide comments on the report. These thanks are not lightly given, for this work was not of the normal "40-hour week" variety. Rather, it was done in a professional and concentrated fashion, and all these players were breaking a lot of new technical ground.

As I write this, I do not know the course that the litigation will take. Yet I feel that this study effort reports a broad and zealous search for the facts and the factors surrounding streambank erosion along the Ohio River. The charge I gave the study group was to uncover as much as possible of the whole story, and this has been done in a highly professional manner. I realize that the reader's conclusions may understandably be colored by the direction in which the reader's own interests lie, but included in this report are the facts as well as our own conclusions.

We made a commitment to furnish this report to the litigants, and I have also told other interested groups that we would share this report with them. I encourage readers to comment on the document, and ask that you contact by mail my steering group vice chairman with your comments: Mr. Aarne Kauranen, Chief, Technical Engineering Branch, U.S. Army Corps of Engineers, Ohio River Division. P.O. Box 1159, Cincinnati, Ohio 45201.

E. R. HEIBERG III
Brigadier General, USA
Division Engineer

15 July 1977

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I INTRODUCTION

1. <u>Purpose</u>. The primary objective of this study was to develop and analyze technical and historical data to arrive at professional and documented conclusions as to whether the raising of the pools behind the Cannelton and Meldahl navigation structures was a cause of bank slumping or erosion at twenty-two specific sites. A secondary objective was to gather data that can be applied to other pools on the Ohio River and tributaries in predicting potential erosion, its causes, its probable extent, and its timing. This report is a summary of this study to include the data developed by on-site investigations.

2. <u>Authority</u>. The study was authorized by the Division Engineer, Ohio River Division, in meeting on 7 April 1977 with Division and District representatives. The study was activated by 11 April 1977 ORDED letter, "Ohio River Division Study Group for Bank Erosion Claim Litigation."

3. <u>Organization</u>. The organization of the study included a steering committee, field study group, consultants, and photo interpretation team.

a. <u>Steering Committee</u>. The general function of this committee was to provide overall guidance to the field study group in accomplishing the stated objectives prior to the 15 June 1977 target date. Steering Committee members were:

BG E. R. Heiberg III (Chairman)	Division Engineer, Ohio River Division
Mr. Aarne O. Kauranen (Vice Chairman)	Engineering Division, Ohio River Div.
Mr. Richard C. Armstrong	Planning Division, Ohio River Division
Mr. Wesley C. Jockisch	Office of Counsel, Ohio River Division
Mr. Jacque S. Minnotte	Engineering Division, Pittsburgh Dist.
Mr. Harold W. Beemer	Engineering Division, Huntington Dist.
Mr. William E. Leegan	Engineering Division, Louisville Dist.

b. <u>Field Study Group</u>. This group was in charge of the actual work on the study with direct responsibility to the Steering Committee. Field Study group members were:

Mr. William H. Browne (Leader)	Hydraulic Engineer, Ohio River Division
Mr. Laszlo Varga	Hydraulic Engineer, Ohio River Division
Mr. H. Marshall Fausold	Soils Engineer, Pittsburgh District
Mr. Michael F. Spoor	Environmental Analyst, Huntington District
Mr. Lewis A. Smith	Hydraulic Engineer, Huntington District
Mr. David A. Beatty	Hydraulic Engineer, Louisville District
Mr. Jeremiah S. Parsons	Biologist, Louisville District

Mr. W. E. Kreisle, Civil Engineer, Louisville District, was detailed to work with the Study Group as Administrative and Technical Coordinator for surveying, mapping, and aerial photography in addition to serving on the photo interpretation team.

c. Consultants. Leading experts in specialized fields were retained to advise, consult and assist the Field Study Group in the investigation and the preparation of this report. These consultants are listed below.

Dr. D. Joseph Hagerty	Professor of Civil Engineering University of Louisville
Dr. Elmer Harp, Jr.	Professor of Anthropology Dartmouth College
Dr. Varley Earl Wiedeman	Professor of Biology University of Louisville
Dr. Daryl B. Simons	Professor of Civil Engineering Colorado State University
Dr. Stanley A. Schumm	Professor of Geology Colorado State University
Dr. Pai Tao Yeh *	Professor of Civil Engineering Purdue University
Dr. Richard W. Birnie *	Assistant Professor Department of Earth Sciences Dartmouth College

* Drs. Yeh and Birnie were active participants in the photo interpretation study.

d. A photo interpretation team was established to develop historical background on natural and manmade changes within the Ohio River basin as they affect the riverbanks. Mr. Robert E. Frost of the U. S. Army Engineer Topographic Laboratories staff was in charge of the photo interpretation study. Members of the team were as follows:

Mr. Robert E. Frost	Civil Engineer Engineer Topographic Laboratories
Mr. Robert Satterwhite	Botanist Engineer Topographic Laboratories
Ms. Claudia Newbury	Geologist Engineer Topographic Laboratories

Mr. George Newbury III	Biologist Engineer Topographic Laboratories
Dr. P. T. Yeh	Civil Engineer Purdue University
Dr. Richard W. Birnie	Geologist Dartmouth College
Mr. Vernon Anderson	Geologist Photographic Interpretation Corp.
Mr. Roger Arend	Civil Engineer Photographic Interpretation Corp.
Mr. David Lichy	Geologist Coastal Engr. Research Center
Mr. Bobby Littlejohn	Civil Engineer Memphis District
Mr. Richard Lenning	Biologist Kansas City District
Mr. Andy Maser	Civil Engineer St. Louis District
Mr. Clyde Renz	Engineering Geologist Rock Island District
Mr. Wallace Walters	Hydraulic Engineer Vicksburg District
Mr. Charles Stevenson	Soils Engineer-Geologist Pittsburgh District
Mr. Silvio Iera	Civil Engineer Pittsburgh District
Mr. Alfred Whitehouse	Geologist Pittsburgh District
Mr. Robert Cole	Landscape Architect Pittsburgh District
Mr. Charles Nelson	Biologist Huntington District
Mr. Robert Moslowski	Archaeologist Huntington District

Metropolis, Illinois, is 17.3 inches. This gaging station monitors a drainage area of 203,000 square miles and is 37 miles upstream of the mouth and 9-1/2 below the Tennessee River. The maximum annual runoff of 29.7 inches occurred in 1950 and the minimum of 8 inches occurred in 1941.

Mean annual runoff from the Allegheny and Monongahela Basins is more than 23 inches; this is between 58 and 60 percent of the average precipitation, whereas in the Wabash Basin the mean annual runoff is 12.8 inches or about 31 percent of the average precipitation. The mean annual runoff for tributary branches varies considerably within a particular drainage basin. For example, in the Monongahela Basin, mean annual runoff from small streams has been greater than 32 inches and in the Wabash Basin less than 11.

Throughout most of the Basin, 1950 was a year of high average runoff. Years of low average runoff within the tributary areas were 1941 and 1954. Variations in climatological conditions and runoff characteristics may cause the year of maximum or the year of minimum runoff to differ in adjacent basins. The maximum tributary runoff year for the Allegheny Basin from 1927 to 1959 was 33.1 inches during 1956, while the minimum was 16.6 inches in 1954. An extreme low annual runoff, six-tenths of an inch, occurred in the Little Wabash Basin in 1931. The highest annual runoff at this same location was 26.8 in 1950.

The Wabash, Great Miami, Little Miami, Hocking, Muskingum, and Beaver River Basins exhibit somewhat similar runoff characteristics, and may be put in a common hydrologic grouping. The Green, Salt, Kentucky, Licking, Big Sandy, Guyandotte, Kanawha, and Little Kanawha River Basins fall into another group; the Allegheny and Monongahela River Basins into a third; and the Cumberland and Tennessee River Basins, because of their longer east-westerly orientation, into yet a fourth group.

Although the average monthly precipitation is fairly well distributed throughout the year, runoff is greatest during the winter and early spring months and lowest in late summer and fall. The highest mean monthly runoff occurs in March or April, dependent on location within the basin, and th lowest occurs in September or October. The maximum monthly total runoff was experienced in January or March, depending on the location.

e. Wind. Prevailing winds, with velocities averaging 6 to 12 miles per hour, are generally from a southerly or southwesterly direction on the plateaus, but usually originate in a more westerly direction in the mountains. Winds with velocities exceeding 50 miles per hour have occurred in all months of the year from each direction except east. Maximum winds have exceeded 80 miles per hour. Damage from hurricanes is uncommon as only the eastern portion of the Basin is exposed. An average of six

tornadoes a year strike Indiana, Kentucky and Tennessee, and half that number also hit the eastern states of the Basin. High winds may also be associated with thunderstorms or the intense large-area storms which occur on the average of 30 times a year in Pennsylvania and 50 times in Kentucky and Tennessee.

f. Ice on Streams. Ice occurs on all streams in the basin, varying in thickness and duration, depending on location, exposure, streamflow, and length of cold spell. Ice more than 18 inches thick has formed on tributaries. Ice on the Ohio main stem occurs more frequently in the upper reaches; although the river froze over for nearly its full length in the winter of 1976-1977, this is a somewhat rare occurrence. In some years ice has interfered with navigation.

Prior to the construction of the high lift dam system authorized in 1954 river freezing occurred more often. The new, deep pools have reduced river freezing, chiefly because they act as heat sinks and it takes longer for them to freeze.

3. Economic History of Ohio River Basin Navigation. Commercial transportation on the streams of the Ohio River Basin has evolved from the use of bark and dugout canoes and flat-bottomed bateaux in the 1600's to the operation of today's diesel-powered barge-tows. As the nation grew, the rivers became the highways by which settlers gained access to the inland regions. Communities were established on water-routes, and the streams became the transportation and communication links between them.

People of the settlement era used mostly flatboats, in one direction downstream. This mode soon proved insufficient for the growing trade between the cities and the frontier, and keelboats answered the need for better water transport. In 1819 it was reported that 500 keelboats were on the Ohio main stem and its tributaries. Although the keelboats lost their lead to the steamboats, they continued in use until after the Civil War on streams too small for river steamers, and even on the Ohio River in periods of low water.

In 1811, just 4 years after the invention of the steamboat, the river steamer NEW ORLEANS was launched at Pittsburgh and began service between there and New Orleans. Thus was born the era of the packet, which revolutionized river transportation.

As the nation developed, the need for transporting raw materials and manufactured goods brought efforts to link the larger rivers by tributary canalization and manmade connecting canals. This resulted in the building of a remarkable network of canals by state governments and private enterprise. These waterways helped tie the country together, by connecting the eastern coastal area with the middle west, and speeding the settlement of the Ohio Basin. The rapid expansion of steamboat navigation prompted Congress to authorize the improvement of the streams

on a planned systems basis. The first Federal money for river development was appropriated by Congress on 24 May 1824 in "An Act to Improve the Navigation of the Ohio and Mississippi Rivers." The waterways thus became the lifeline of the country.

The Civil War dealt river transportation a blow from which it would not recover for many years. Hundreds of steamboats were burned, and navigation came to a virtual standstill. In the two decades before the Civil War, the railroads were usually short feeders from interior points to the trunkline water routes. In the war years, railroad construction, while very limited in the South, was actively carried on in the states north of the Ohio River, where the network was extended and connected to eastern seaboard lines. Further rapid expansion of the railroads after peace together with severe competition (lasting until 1877 when the principal lines entered into a rate agreement) diverted much of the western commerce from the Ohio-Mississippi Rivers system to Atlantic ports. Meanwhile, interest in the waterways as arteries of transport diminished although the barge continued to serve commerce by moving some basic bulk commodities such as coal and iron ore. By the latter part of the 19th century, traffic on several streams had revived to such an extent that improving the basin's waterways became of national importance. In 1878 the Federal Government started the 6-foot canalization of the upper Ohio River by a system of movable dams with locks, 110 feet wide by 600 feet long. In that period, the Government also acquired the state and private navigation systems on the tributaries and proceeded to rebuild and extend these systems to provide an economical means of transport for the resources in the contiguous areas. The investment was justified and by 1890 the combined annual volume of coal traffic on the Ohio, Monongahela, and Kanawha Rivers had reached 10 million tons.

The outlook for inland navigation became brighter; financial, commercial, and civic organizations with interest in water transport had taken on new life. Realizing that the open-channel improvement of the Ohio River did not provide for the proper development of navigation, Congress in 1910 approved the extension of the 9-foot slackwater system throughout the waterway.

Congress, through the Transportation Act of 1920, declared its intent to promote, encourage, and develop water transportation. Work was accelerated on the canalization of the Ohio River, which was completed in 1929. The 22 million tons of commerce moving on the Ohio River that year was 50 percent greater than the annual tonnage considered in the plan's justification.

In the three decades following World War I, further improvements were made on the Ohio River, and major improvements were made on the principal tributaries. Development of commerce on the Ohio River system during that period is shown in the following tabulation:

Stream	Total Freight Traffic in Thousand Tons *			
	1918	1928	1938	1948
Ohio River	6,170	20,940	20,590	42,790
Monongahela River	16,540	27,410	15,330	30,010
Kanawha River	1,280	1,600	3,330	5,910
Allegheny River	2,290	3,480	2,350	3,170
Tennessee River	900	2,270	1,180	3,110
Cumberland River	300	600	500	1,350
Kentucky River	124	145	207	73
Green and Barren Rivers	174	590	230	47

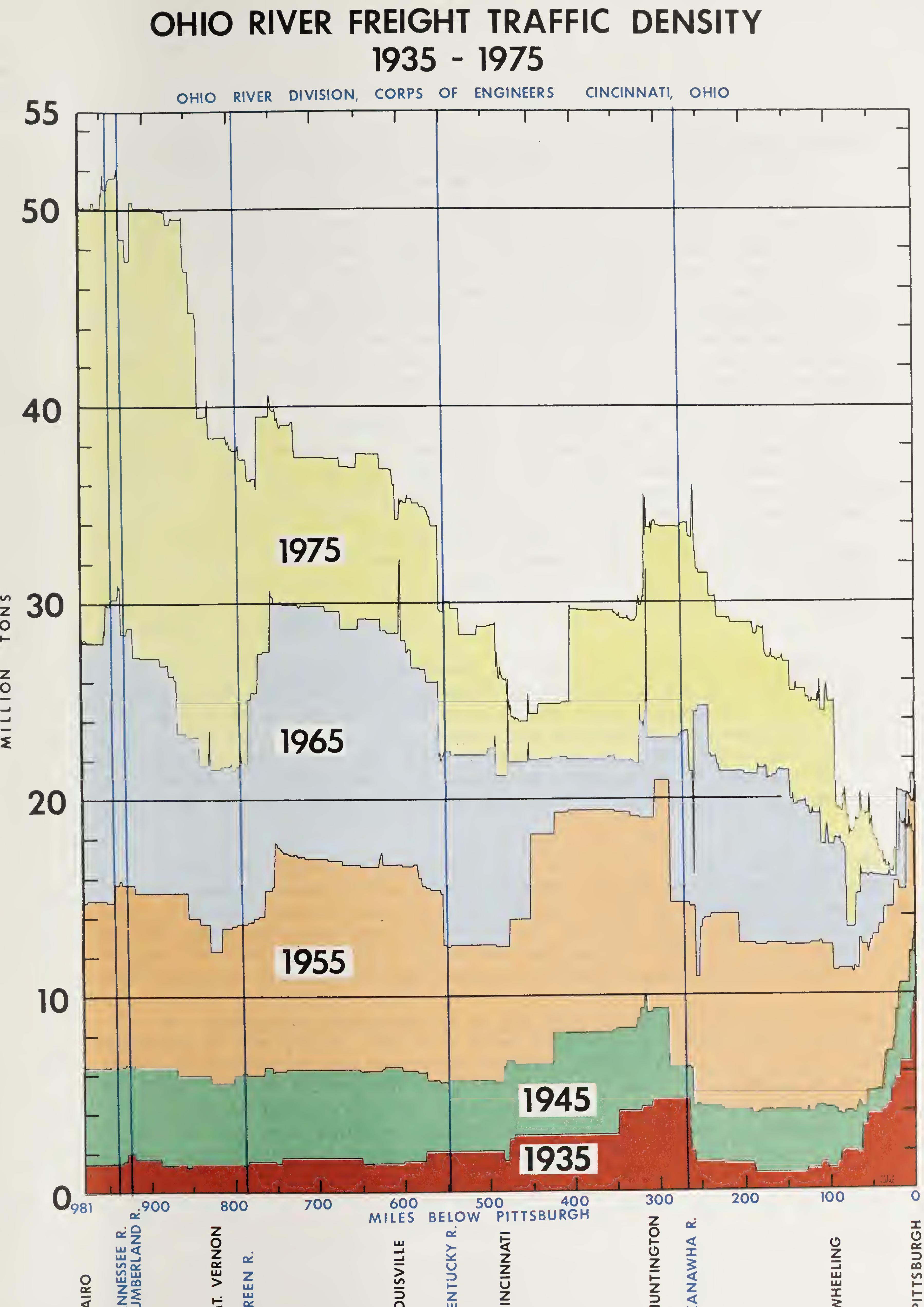
* Total tonnage carried on the waterway.

Within the last quarter century both the commerce mix and the traffic pattern on the Ohio River system changed. Whereas Ohio River traffic was once mainly in coal and steel products which moved downbound, new commodities were added to both upbound and downbound commerce. Included were petroleum and its products, dry and liquid chemicals, bauxite, cement, grains, and a variety of other goods. In the early 1950's upbound traffic on the Ohio was approaching the volume of downbound commerce. Tonnages increased greatly in the basin system. This is illustrated by Fig. II-1 which shows the growth of freight tonnage past a given point for the period 1935 through 1975.

To meet the growing demand for water transportation facilities, Congress has authorized the replacement of obsolete critical elements in the basin's navigation system. Current work includes a modernization program for the Ohio River which was started in 1954.

Today, the Ohio River serves as one of the major inland waterways of the United States. The economy of a large portion of the nation is closely related to this river. While a significant amount of employment is directly related to the Ohio River, a much larger magnitude of employment is indirectly related to the river through manufacturing, mining, commercial, and service operations. The percentage of our Gross National Product generated in the Ohio River Basin and the portion of this related to Ohio River navigation cannot be readily itemized; however, these quantities are a significant part of our national economy. Today, over half the intercity tonnage along the Ohio River is carried on river barges.

The importance of this waterway was brought to the forefront this past winter when navigation along the river was severely restricted by the coldest weather recorded in the Ohio River valley. Many communities were faced with critical energy shortages since they were dependent upon the river for transportation of not only goods and raw materials for industry, but also of their basic fuels.



OHIO RIVER FREIGHT TRAFFIC DENSITY
1935 - 1975
OHIO RIVER DIVISION, CORPS OF ENGINEERS CINCINNATI, OHIO
MILLION TONS
55
50
40
30
20
10
0
1975
1965
1955
1945
1935
981
900
800
700
600
500
400
300
200
100
0
MILES BELOW PITTSBURGH
CAIRO
TENNESSEE R.
CUMBERLAND R.
MT. VERNON
GREEN R.
LOUISVILLE
KENTUCKY R.
CINCINNATI
HUNTINGTON
KANAWHA R.
WHEELING
PITTSBURGH

FIGURE II-1

4. Evolution of Navigation. a. Development of River Transportation. Historically the first mode of transportation used by the settlers was the flatboat, which was used on the Ohio River before the end of the Revolution. These boats were of simple, wooden construction with lengths ranging from 15 to 50 feet and they were suitable for navigation through the shallow waters of the unimproved river owing to their stability. Flatboats depended on current for motive power; their ungainly bulk, shape, and lack of power prevented them from navigating upstream. Canoes and dugouts were used for upbound transportation from the earliest times, but they had severe limitations in cargo-carrying capacity. Thus, a solution had to be found for upbound transportation, which was furnished by the development of the greater capacity keelboats and barges. The "keel" was the rigid longitudinal timber which bore the brunt of collisions, and the hull was constructed of ribs covered by planking. The dimensions of keelboats varied from 30 to 75 feet in length and from 5 to 10 feet in width, with cargo capacity from 15 to 40 tons. Keelboats carried masts and sails which were used when possible, but the boats were commonly propelled by a crew of men with iron-tipped poles which were pushed against the bottom, or by pulling with long ropes from the bank. Keelboats first appeared on the Ohio River in the 1790's. Navigating the river in keelboats was fairly dangerous because they frequently had to run close to the bank to avoid currents, increasing chances of damage to boats.

The invention of the steamboat is generally credited to Robert Fulton, whose CLERMONT first operated on the Hudson River in 1807. It took only 4 years for the appearance of the first steamboat, NEW ORLEANS, on the Ohio River. Five years later, the WASHINGTON was specially constructed for navigating generally shallow waters. With steam power, more cargo could be transported with substantial reduction in travel time. Reductions of as much as 80 percent in travel time and costs were realized.

The first period of the steamboat boom was in the decades from 1830 to 1855, when a great shipbuilding industry was developed along the Ohio River. During most of this time, the total number of steamboats constructed was well over 100 each year. A series of low water periods beginning in 1855 stopped the further expansion of river navigation, and for a time shipping companies found keen competition from newly organized railroads.

b. Navigation Improvements on the Ohio River. During the westward expansion of the nation, the Ohio River fulfilled an important role as an artery of commercial and passenger traffic. However, in its natural state the river was not suited for year-round navigation. An especially serious obstacle to navigation was the Falls of the Ohio River where a series of rapids over rock outcrops created hazardous navigation conditions during a significant portion of the year.

The first attempts to improve navigation were clearing and snagging of the river, and the construction of wing dikes to concentrate the flow, thus creating more depth. The goal of these early improvement projects was to obtain a minimum navigable depth of 3 feet over the bars during low water season, thereby obtaining year-round navigation. From 1825 to 1842 a total of 142 wing and training dams were constructed; however, the original plan of improving the entire river was not completed. The dams were not stable enough, and in some instances their construction resulted in the deposition of sediment. However, clearing and snagging were more successful and improved navigation over the entire river.

New expansion of navigation in the latter part of the 18th Century led to the development of the slack water navigation system. It was decided that a movable dam system permitting a navigable pass during high water, but damming up the pool during low water, would be constructed. The first such lock and dam were built near Pittsburgh. The project objective was to maintain 6-ft navigable depth; however, during subsequent development of the system the objective was modified to provide 9-ft navigable depth. Eventually the system was completed with 49 dams for the entire river by 1929.

A special feature of the earlier Ohio River navigation improvement project was the Louisville and Portland Canal which was a Federally-assisted private enterprise. It was designed to allow year-round navigation around the Falls of the Ohio. The original project had three locks in tandem and was opened in the 1830's, and continued to function until the mid-1860's.

After the second World War, the tremendous increase in river tonnage required larger tows, and delays at the 600-ft long locks of the "slack water navigation system" became a serious obstacle to navigation. The Federal response was substitution of 19 high-lift dams with dual locks (generally 600- and 1200-ft long) to replace the old system. The first three dams of the new system - Montgomery, Dashields, and Emsworth - were completed between 1934 and 1938 in the upper Ohio. Gallipolis was impounded in 1937, with Smithland being currently the only unit of the system under construction. Mound City has been deferred while the rest of the system was completed between 1961 and 1975.

Plate 6 shows the old "slack water" and the new "high lift dam" system.

The canalization of the Ohio River began in 1878 with the construction of the first movable dam near Pittsburgh and was completed in 1929. It initiated the re-expansion of river navigation by providing a year-round dependable navigation depth of 9 ft. After 1945, the conversion from steam to diesel power provided cleaner and more economical operation and today steamboats have practically disappeared from the river.

Recent years brought a tremendous increase in freight moved on the Ohio River, resulting in increases of tow and barge sizes, and requiring more powerful towboats. Barge sizes, standardized generally at 26 x 175 ft during the initial period of "slack water navigation" for transportation of coal and other commodities, have increased to 35 x 195 and 52 x 290 ft. The largest barges are used mostly for oil and gasoline transportation. Concurrently with the expansion of freight volume, tow sizes increased also from an average of 8 to 10 barges/tow in earlier times to 15 to 16 barges/tow (fully or semi-integrated) coal or gasoline tows of today. The modernization of the Ohio River navigation system responded to the needs of the shipping industry by providing a smaller number of dams with larger locks eliminating time-consuming and costly multiple lockages.

5. Evolution of Flood Control. The Ohio River basin lies directly in the path usually followed by cyclonic disturbances as they move from west to east in the winter and early spring. For this reason, the basin frequently has more than normal rainfall from January to March, when infiltration, transpiration, and evaporation are at a minimum, and rainfall-runoff relationships attain their maximum. This is a major factor accounting for the large flood flows likely to occur. Another contributing factor is the rapid runoff caused by the slopes of the mountainous regions bordering the basin to the east and southeast. Furthermore, the basin's pear shape tends to synchronize flood flows originating in the upper or narrow portions with those of the three large tributaries draining the wide area toward the mouth, the Wabash, Cumberland and Tennessee Rivers. On the Ohio and tributaries, flood problems have been affected by encroachment of buildings, bridges, railroads, highways, and other structures, drainage of forest swamp lands, improper land use, and forest depletions.

In this century, the devastating floods of March 1913, March 1936, and January-February 1937 caused great economic losses and considerable loss of life. The 1937 flood was the most disastrous ever experienced in the basin, causing damages estimated at that time in excess of $400 million (in 1937 dollars). More than 500,000 persons were driven from their homes and 65 lost their lives. Virtually all rail, telegraph, telephone, power, and highway facilities along the Ohio River and its major tributaries were interrupted for periods lasting from a week to a month. In general, business and industry were paralyzed.

Because of the basin size, no single flood brought maximum flooding throughout the basin. The 1937 flood was the highest in most sub-basins, particularly those in the lower Ohio River Basin. The eastern sub-basins generally have recorded the 1936 flood as the maximum of record. The 1913 flood was centered over the tributaries in the middle of the basin, north of the Ohio. More recent floods such as January 1957, January 1959, March 1963, and March 1964 have generally caused the maximum recorded flows in several major Ohio River tributaries. On many smaller tributaries, local flash floods are the maximum of record. In April 1977 several West Virginia and eastern Kentucky tributaries recorded maximum floods.

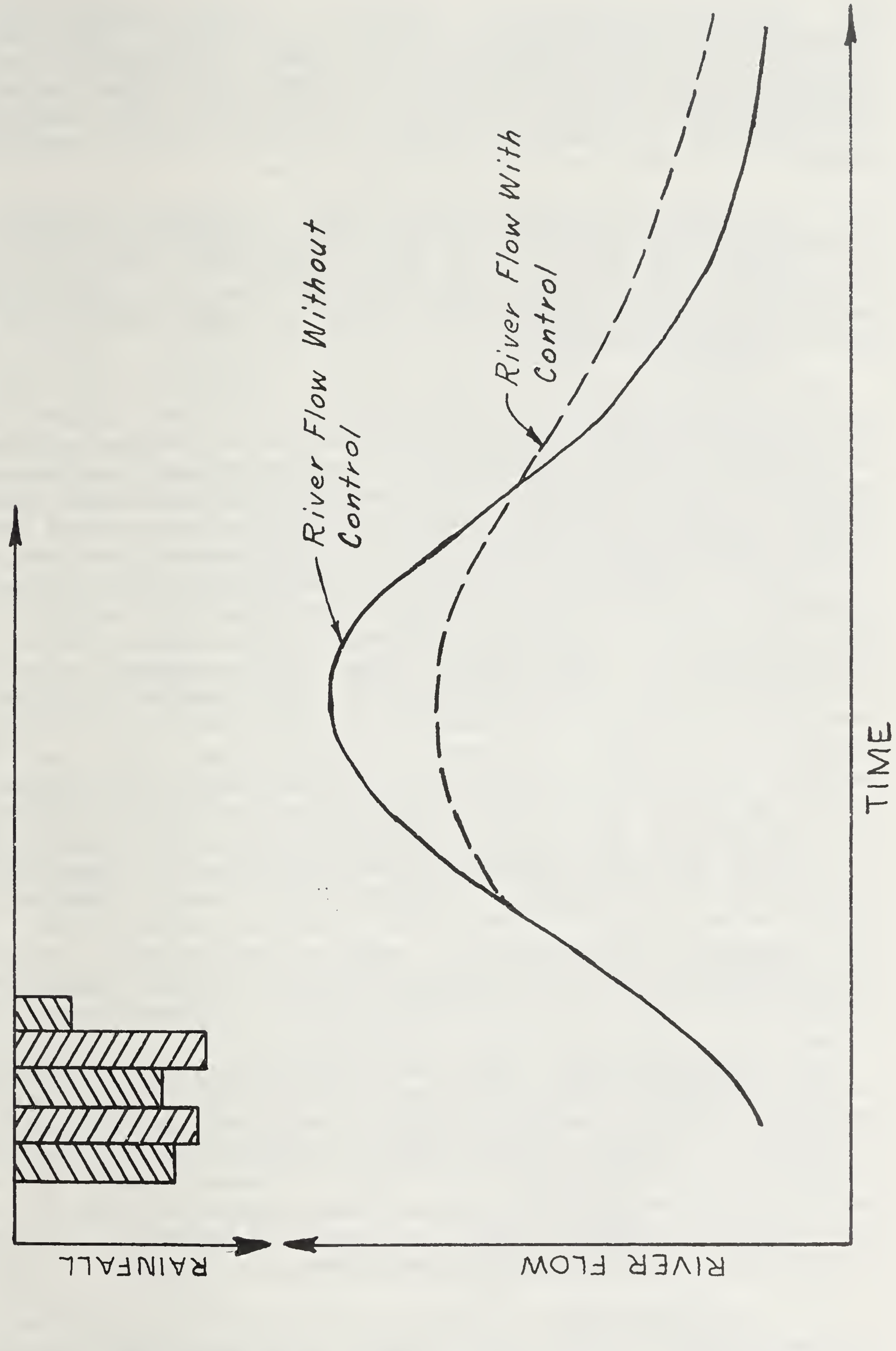
Early efforts at flood control in the Ohio River Basin began about 1808 when private landowners built levees in the Wabash River Basin to protect their farmlands. Later, local groups built levees and walls to partly protect Shawneetown, Illinois; Portsmouth, Ohio; Lawrenceburg, Indiana; and other communities against Ohio River floods. Following the great flood of 1913, the Miami Conservancy District was formed by local interests which built, without Federal or state aid, five control reservoirs and numerous local protection projects in the Great Miami River Basin. Other entities have followed this approach to mitigate local and tributary problems.

The development of Federal reservoirs in the Ohio River Basin began in 1934 when the Corps of Engineers, in cooperation with the Muskingum Conservancy District, constructed 14 reservoirs in the Muskingum Basin. In that same year at Shawneetown, Illinois, on the Ohio River, the Corps of Engineers, under authority of the 1928 Flood Control Act, raised and enlarged the existing levee which was originally built by the city in 1875.

The current Ohio River Basin plan for flood control includes an integrated Federal and non-Federal program consisting of a system of reservoirs, local protection projects and watershed projects on tributaries and local protection projects along the Ohio River. Also, various types of non-structural measures have been undertaken and more are planned in certain flood plains.

A portion of the system operated by the Corps in the Ohio River Basin consists of 70 tributary reservoirs, which are either completed or far enough along towards completion, to be effective in reducing floods. Of the water reaching the Cannelton and Meldahl pools, about 30 percent comes from drainage areas controlled by flood control reservoirs. These projects store water during periods of high runoff and release it later, thus contributing to a stabilization of river flows by reducing flood peaks and supplementing low flows.

Figure II-2 illustrates the effect that "30 percent control" has on water flow from a heavy rainfall. The controlling structures allow the Corps to "shave" the top off of flows which would otherwise flood. Obviously, the "typical" chart applies only to points downstream of areas partly controlled. Basins without flood control dams still exhibit "natural" flooding. This activity also tends to contribute to stability of the river by reducing the amount of rise and fall of the water levels and consequently reduces the changes that would contribute to the mass instability of the banks. More specifically, this condition reduces seepage forces acting on the banks.



SCHEMATIC DIAGRAM OF RIVER FLOW MODIFICATION

FIGURE II-2

6. Biological Elements. a. General. Since the 1920's, the Ohio River has been modified by navigation structures. Flood levels have not been appreciably altered by these projects; however the river no longer experiences the lower stages associated with low flows since their construction. The structures have imposed changes on the river and, as such, have imposed some changes on its associated biota.

The general discussion of the basin's biological elements includes their recent history as well as major associations, such as the upland forests, the lowland forests, agricultural areas, the aquatic environment and the riparian fringe area, where the impact of changing pool levels is most pronounced.

b. Brief History of Forest Cover. The forests of the Ohio River Basin, like the river, have little resenblance to those confronting early settlers some 200 years ago. They had spread from the south in the wake of retreating glaciers and had stood thousands of years. Their composition varied with their setting, oak-hickory on the upland slopes grading to beech-maple forests in the lowlands and the terraces and to the mesophytic species of the bottoms and riverbanks. Growth was luxuriant and presented a formidable barrier to settlement. The forests were a hindrance to travel, a haven for unfriendly Indians, and an obstacle to homesteading. They were considered a nuisance and clearing began with the first settlers. The clearing increased as more settlers arrived and accelerated in the 19th Century as uses for the timber were developed. Burning provided wood ash, which contributed a substantial income as a byproduct of the destruction of timber, bringing as much as $100 a ton in 1819. Tanning bark was peeled from the fallen trees and used in the growing leather industry. The charcoal furnaces of southern Ohio and northern Kentucky influenced the forest cover of the region. By 1883, only 18 percent of the State of Ohio had woodland cover, whereas in 1853 it was still 54 percent wooded (Diller, 1956). With advances in transportation, lumber production rose. In 1900, almost a billion board feet were produced in Ohio. In 1910, the Louisville paper reported that most of the harvestable timber had been removed from Kentucky.

c. Upland Forest. The basin lies within the area of the Great Eastern deciduous forest. Uplands in the vicinity of the river are generally in mixed mesophytic species, dominated largely by oak and hickory. All existing upland forest is second or third growth, but large areas of mature stands are found on steeper slopes. These forests include a diverse understory and provide habitat for a variety of animals, such as the white-tailed deer, fox, squirrels and other small mammals, numerous birds, snakes, lizards and insects.

d. Lowland Forest. Little of the once-extensive lowland forest, remains, as most of these lowlands have been converted to agricultural production. Some stands and woodlots persist which consist largely of maple and oak on well-drained sites grading to the sycamore-cottonwood-American elm-silver maple associations of the bottomlands. Dense undergrowth is common and such stands provide habitat for raccoon, muskrat, mink, skunk, various reptiles and amphibians, numerous insects and a variety of bird life.

e. Agricultural Land. Agricultural areas include most of the flat land near the river. Crops such as corn, soybeans, and wheat are encountered. Land not suitable for cropping is often in pasture. The activity limits the use of such lands for most wildlife, but some species such as cottontail rabbit, quail, dove, and various small animals find this habitat acceptable.

f. Aquatic Environment. The navigation system has impinged on the aquatic environment by eliminating the riffle-pool system which formerly existed during low-flow conditions. Lower bank and shoal development has been modified and species of shallow water habitat have been largely displaced. Few aquatic plants are found near the banks and none are found in the channel. With the dampening of variation, the benthic fauna has been greatly reduced. The rich clam and mussel diversity has been greatly reduced, largely from land-use changes and associated pollutants. The macroinvertebrate fauna is more typical of lakes than the riverine environment. Fish species reflect the lake-like character of the river, with few stream species appearing in recent surveys. The most common species are the emerald shiner, gizzard shad, carp, skipjack herring, fresh-water drum, and channel and blue catfish. Other fish of interest commonly found in the river are buffalo, carpsuckers, sauger, walleye, gar, crappie, threadfin shad, and the unusual relics, the bowfin and the paddlefish. Reptiles and amphibians are common in the sloughs and backwaters. Waterfowl frequent the river and many shorebirds pause in migration at the Falls of the Ohio, at Louisville at the head of the Cannelton pool.

g. The Riparian Fringe. This classification is artificial as the "Riparian fringe" is maintained along the river by man's activities, largely through agriculture, road-building, industry and urbanization. Generally, the banks are not adaptable to those activities and have been left to create a narrow fringe of trees and shrubs along the river.

Progressing landward from the shore, the tree species commonly encountered are willow, silver maple, cottonwood, box elder, American elm, and a gradation of other species into the lowland forest, in that order. The willow and silver maple are adaptable to conditions nearest the water, and their propagation by sprouting tends to form dense root systems and thickets of the trees. These species can contribute to stabilizing the banks by holding soil and acting to dissipate wave energy against the shore. Extensive lateral root systems lessen their tendency to topple.

A varied understory occurs along the banks, commonly including buttonbush, spicebush, Virginia creeper, poison ivy, nettle, ragweed, and some grasses. Honeysuckle and coralberry commonly form thickets at higher levels.

The fringe offers habitat for muskrat, mink, and a variety of small mammals, along with amphibians, reptiles and numerous birds.

Species present, their density, and their diversity vary along the bank with slope, soil type, and a variety of other factors. Vegetational associations are site specific and analyses are included in the individual site descriptions.

7. <u>Additional Background</u>. a. <u>General</u>. The locks and dam projects at Meldahl, Cannelton, and Newburgh were built under the authority of the River and Harbor Act of 3 March 1909, Public Law 317, 60th Congress, Second Session.

The Meldahl project is located 436.2 miles below Pittsburgh and 1.7 miles below Chilo, Ohio. Construction of the locks began in 1959 and they became operational on 16 November 1962. Construction of the dam started in 1961 and the dam became operational on 22 December 1964. The normal pool level of 485 ft m.s.l. was reached on 28 March 1965. This lock and dam structure replaced four old low-lift Locks and Dams 31, 32, 33 and 34.

The Cannelton Locks and Dam Project is located on the Ohio River at a point approximately 3 miles upstream from Cannelton, Indiana, at mile 720.8 below Pittsburgh. This project replaces old Locks and Dams 43, 44 and 45. Construction of this project was initiated on 28 June 1962 with construction of the dam itself beginning on 16 October 1965. The project was completed and dedicated on 2 November 1974.

The Newburgh Locks and Dam was constructed on the Ohio River at a point slightly less than 2 miles upstream from Newburgh, Indiana, at mile 776.1 as a replacement structure for old Locks and Dams 46 and 47. Construction of the project was commenced on 27 April 1965, with construction of the dam itself beginning on 19 June 1970. The project was completed and dedicated on 25 October 1975.

b. <u>Criteria for Flowage Easements</u>. The general criteria for the establishment of real estate easement lines through the navigation pool area on the Ohio River locks and dams was determined on the same basis that was used on other navigation projects. In accordance with previously established criteria, the lower limit of easement acquisition along the mainstream was the ordinary high water profile, which is defined as a line to which the river rises so frequently and for such periods of duration as to impress upon the soil and vegetation of the lower banks characteristics distinct from that of the upper banks. This definition has been developed by judicial precedence. This line was the boundary line above which the Government made compensation. A stream profile of the ordinary high water line was established by making several observations through the areas and using a line composed of the averages for those observations.

c. <u>Flowage Easement Elevations</u>. The upper limit of acquisition is based on the ordinary high water flow superimposed on the new pool level at the dam. However, for the Cannelton pool, an elevation 3 feet above the new pool level was used as a starting point for superimposing the new ordinary high water line. The ordinary high water and flowage easement lines are shown on Plates 7 and 8.

In the Meldahl Pool the upper limits of flowage easements established a series of horizontal 1-foot increments which were set at a minimum of 3 feet above the superimposed ordinary high water line after the dam was completed and the new normal pool was established. The lower flowage easement limits were established as the existing ordinary high water line of the Ohio River. The flowage easement line for all tributaries was extended as a horizontal line at the elevation of the Ohio River guide flowage easement line at the mouth of the tributary. Ordinary high water and flowage easement lines are shown on Plate 9.

The level of the Newburgh normal pool is entirely below the ordinary high water line; consequently, the acquisition of interests in lands along the main stream was not required.

The breakdown of the number of tracts per project and the means of acquisition are as follows:

	NUMBER AND PERCENT OF FLOWAGE EASEMENTS					
PROJECT	Purchased		Condemned		Acquired	
	No.	%	No.	%	No.	%
Meldahl	1,632	(76.2)	509	(23.8)	2,141	(100.0)
Cannelton	1,130	(83.7)	220	(16.3)	1,350	(100.0)
Newburgh	301	(95.3)	15	(4.7)	316	(100.0)
Total	3,063	(80.5)	744	(19.5)	3,807	(100.0)

The elevation of flowage easements acquired along the Ohio River for each project is as follows:

River Mile	Elevation of Flowage Easements
MELDAHL POOL	
436.0 to 428.0	489
428.0 to 420.4	490
420.4 to 413.4	491
413.4 to 460.8	492
460.8 to 400.6	493
400.6 to 394.0	494
394.0 to 388.6	495
388.6 to 384.0	496
384.0 to 379.4	497
379.4 to 375.2	498
375.2 to 371.6	499
371.6 to 367.8	500
367.8 to 364.4	501
364.4 to 360.8	502

III. COLLECTION OF DATA

1. General Data. a. Geology and Soils. Reconnaissance of geology and soils conditions was conducted by the Corps for Newburgh, Cannelton, and Meldahl pools using aircraft and surface vessels. Data were collected at litigants' tracts and adjacent areas to obtain facts regarding significant factors for bank erosion.

Data as obtained in the field were recorded by ownership, tract number and date. Property boundaries were referenced and the tract river frontage walked out to determine existing conditions and to locate suitable riverbank sites for more detailed examination and sampling.

Tract reconnaissance observations were recorded and included: photographs, weather conditions, river stage, tributary stream relations, topography, slope conditions, surface runoff characteristics, seeps and springs, drainage controls and stream relocations, bank protection efforts, extraction and dredging operations, structural influences, tree and fence lines, utilities, and wells. At sites selected for detailed field examinations and sampling, the location was referenced to a stake set near the top of bank. Bank materials were exposed by trenching, scarifying continuous reaches, test pitting, or hand auger borings where near-horizontal benches made trenching impractical. At each site detailed examination and logging of exposed and augered materials were accomplished by geotechnical staffs. Materials were visually classified, general water content noted, and with representative samples being obtained. Buried materials including vegetation, charcoal, coal, plastic and apparent archaeological sites were recorded. Undisturbed samples were obtained at locations in proximity to continuous disturbed sampling locations. These samples were referenced for location and orientation, placed in proper containers and sealed. At Dames and Moore laboratory facilities, the disturbed samples were classified using the Unified System designations. Classification tests included sieve and hydrometer analysis of grain size distribution, natural moisture content and Atterberg Limits. The undisturbed samples were examined at Waterways Experiment Station and radiographic and petrographic data were derived. Krueger Enterprises Geochron Laboratories conducted radiocarbon age determinations for selected wood samples. Geotechnical information is presented on bank cross sections. References for these studies are listed in the Bibliography.

Ohio River area mapping has been conducted by the Corps of Engineers since the late 1800's. During the 1950's and early 1960's mapping was undertaken for use in planning additional navigation structures. These areas were field controlled (3rd order accuracy)

and were mapped by photogrammetric methods. In 1976-1977 the litigation sites in the Newburgh, Cannelton, and Meldahl pools were photographed at low altitudes, with controls, and were surveyed in the field.

Cross sections obtained by photogrammetric methods prior to and after the construction of the high-lift system were compared. Average variances of 5 to 10 feet horizontally and 2 to 4 feet vertically can be expected using these methods.

b. Hydrology, Climatology and Sedimentation. The data collected for this portion of the study can be divided into six broad categories:

Discharge

Sediments

Waves

Ice

Material Removal

Localized Shoreline Impacts

In the following subparagraphs, a general description of the types of data collected for each of the referenced areas is covered. Data developed in these areas were considered important to support the evaluation of the complex mechanisms resulting in bank changes at the sites under study. References for these studies are listed in the Bibliography.

(1) Discharge. Within the broad category of "discharge", data were collected relative to impoundments, stages and durations, runoff, ordinary high water trends, and flow velocities. The time-history relationship between controlled and uncontrolled drainage areas within the Ohio River Basin was developed. Stage hydrographs were prepared using gaging stations in the vicinity of the sites. Stage duration curves for pre- and post-impoundment conditions were also prepared for each site in the Cannelton pool and for gaging stations located in the vicinity of the sites in the Meldahl pool.

In order to determine the relative "wetness" or "dryness" of a given period, cumulative discharge mass curves were prepared using Louisville as a representative station for the period of 1928 through 1976.

Previously, the ordinary high water profiles for pre-project conditions in both pools had been established by visual inspection and

new ordinary high water profiles for post-project conditions were computed on the basis of equivalent flows. These profiles are shown on Plates 7 and 8 for the Cannelton pool and Plate 9 for the Meldahl pool.

Stream velocity measurements were made during April-May 1977 at a total of 19 cross sections in the Meldahl, Cannelton and Newburgh pools. Only one set of measurements was made in the Meldahl pool. In the Cannelton pool, two sets of velocity determinations were made during relatively high stages in April 1977 and relatively low stages in May 1977. The velocity cross sections were at, or in the vicinity of, the sites as shown on Plates 29-50.

(2) Sediments. Available published and unpublished data were collected to obtain information on sediment rates, sediment gradation and changing stream features. The purpose of this investigation was to analyze and establish trends, if any, in sediment yield and sediment transportation for pre- and post-impoundment conditions. Analysis of stream features included the examination of broad general trends in thalweg shifting, both horizontally and vertically, and local bed form changes. Bed material samples were taken at five locations in the Cannelton and Meldahl pools.

(3) Waves. Data collection for this category included measurements of tow- and wind-generated wave heights, and meteorological data on wind speeds, durations, and directions, and the determination of wind-generated wave fetch lengths and directions.

Field measurements of tow- and wind-generated wave heights were conducted by the Waterways Experiment Station in April-May 1977 at nine locations in the Cannelton pool, four locations in the Meldahl pool, and one in the Newburgh pool. These measurements were made at, or in the vicinity of, sites as shown on Plates 29-50. At the same locations wind speeds and directions were determined also.

The long term meteorological data of stations located in the vicinity of the Cannelton and Meldahl pools were used for a basis for analytical determination of wind-generated wave heights and their durations. Fetch lengths were determined at each site using graphical procedures for post-impoundment normal pool conditions. General comparisons were made with those for pre-impoundment normal pool.

(4) Ice. Data were collected on the history of river ice at two locations, Cincinnati, Ohio, and Louisville, Kentucky. Data sources were unpublished Weather Bureau statistics. An effort was made to collect information specifically applicable to the study sites; however, no such information could be obtained. Ice history records of the Ohio River were compared to global trends in climate.

(5) Material Removal. Available Huntington and Louisville District records were obtained to compile a history of dredging required to maintain project depth in the pools under investigation. Also, available records were collected on the history of commercial dredging in the pools. Where applicable, data were referenced to the specific sites under investigation.

(6) Localized Shoreline Impacts. In this category, shoreline works, such as boat docks, marinas and loading facilities were listed and referenced to specific sites under investigation, where applicable.

c. Navigation. General data were collected to determine trends in river navigation practices, volume and characteristics of commercial navigation and volume of recreational traffic on the river. The scope of the data collection included the following specific areas:

(1) Traffic Volume. Data were collected to describe trends of tonnage and vessel traffic in the Meldahl and Cannelton pools before and after the impoundments. Data sources were survey scope reports prepared by the Huntington and Louisville Districts, Corps of Engineers. Where available, the material in the reports was supplemented by field data collected at specific lock and dam sites. A limited review of available records was made to describe the recreational traffic in both pools.

(2) Tow Size and Configuration. Historical trends on the development of towboat horsepower, tow and barge sizes were reviewed. Sources of information were published data on the fleet characteristics of companies navigating the river, and survey scope reports prepared by the Huntington and Louisville Districts. A limited analysis of tow speeds under present conditions was made on the basis of computerized information available in the Districts.

(3) Sailing Lines. At each litigant's tract, changes in sailing lines associated with the impoundment of the pools were investigated and their effect, if any, on the sites was assessed. Sources of information were navigation charts published by Louisville and Huntington Districts. Sailing lines are shown on Plates 10-28.

d. Vegetation and Clearing. Biological data were collected under the categories of general vegetational investigations, specific site investigations, and clearing investigations.

(1) General Vegetational Investigation. A review of the literature was conducted to gather background information. Pertinent literature is cited in the Bibliography.

(2) Site Investigations. Tracts were surveyed for general ground cover, species present, diversity of species, density of vegetation, and age of selected individual trees. Larger trees were aged by increment borings, examined for numbers of annual rings and measured for length. These measurements were used to extrapolate to the approximate age of the tree being sampled.

Forests were sampled using the point-centered quarter method of Cottam and Curtis (1956) as described by Mueller-Dombois and Ellenburg (1974). The data were analyzed and printouts obtained using a BASIC language computer program developed by Wiedeman and Standifer (unpublished) which includes slope justification where applicable and conversion to metric measurements. Sites were indexed by owner's name, tract number and Ohio River mile. Summaries of these analyses are included as Tables III-1 and III-2.

(3) Clearing. All records, inspectors' reports and logs, correspondence, Design Memoranda, contracts and specifications were reviewed. Where possible, field verification was performed.

e. Photo Interpretation. The following is a list of photography obtained for Cannelton and Meldahl pools.

(1) Corps of Engineers' Photography

(a) Cannelton Pool

Photo Date	Scale	Remarks
1930	1:24000	1st aerial mapping
1961, 62, 63	1:18000	pre-construction mapping
1967	1:24000	clearing
1974	1:12000	color-neg permits
1976 (23 Nov)	1:6000	site maps
1977 (2 Feb)	1:6000	ice
1977 (2 Feb)	1:20000	ice
1977 (9 May)	1:6000	post high water

(b) Meldahl Pool

1958-59	1·12000	pre-construction mapping
1974	1:12000	color-neg permits
1977 (22 Mar)	1:6000	site mapping
1977 (12 May)	1:4800	" "

(2) Park Aerial Survey

Photo Date	Scale	Remarks
1973, 74	1:40000	Cannelton pool
1975, 76 & 77	1:40000	Cannelton pool
1975	1:45000	Cannelton pool

(3) Soil Conservation Svc., Cartographic Unit

1970	1:48000	Hancock County, Ky
1956	1:20000	Jefferson County, Ky
1953	1:20000	Lewis County, Ky
1953	1:20000	Greenup County, Ky
1975	1:45000	Hardin County, Ky
1971	1:48000	Crawford County, Ind
1971	1:48000	Harrison County, Ind
1969	1:38000	Floyd County, Ind
1971	1:45000	Clermont County, Ohio

(4) National Archives and Records Service

1937, 40	1:20000	Perry County, Ind
1937, 40, 53, 58	1:20000	Crawford County, Ind
1937, 40	1:20000	Harrison County, Ind
1937, 40	1:20000	Floyd County, Ind
1937, 40	1:20000	Clark County, Ind
1937, 40	1:20000	Switzerland County, Ind
1937, 38	1:20000	Hancock County, Ky
1938	1:20000	Breckenridge County, Ky
1938	1:20000	Hardin County, Ky
1937	1:20000	Bullitt County, Ky
1938	1:20000	Meade County, Ky
1937	1:20000	Jefferson County, Ky
1935, 38	1:20000	Pendleton County, Ky
1938	1:20000	Pendleton County, Ky
1938	1:20000	Bracken County, Ky
1937	1:20000	Mason County, Ky
1938	1:20000	Lewis County, Ky
1938	1:20000	Greenup County, Ky
1937, 38	1:20000	Campbell County, Ky
1938	1:20000	Clermont County, Ohio
1938	1:20000	Brown County, Ohio
1938	1:20000	Hamilton County, Ohio
1938	1:20000	Adams County, Ohio
1938	1:20000	Scioto County, Ohio

(5) Agriculture Stabilization and Conservation Service

Photo Date	Scale	Remarks
1967	1:20000	Crawford County, Ind
1960, 68	1:20000	Floyd County, Ind
1949, 60, 68	1:20000	Harrison County, Ind
1971	1:48000	Harrison County, Ind
1953, 58, 67	1:20000	Perry County, Ind
1949, 59, 71	1:20000	Bracken County, Ky
1951, 64, 71	1:20000	Breckenridge County, Ky
1951, 67	1:20000	Campbell County, Ky
1974	1:40000	Campbell County, Ky
1959, 60, 66	1:20000	Greenup County, Ky
1974	1:40000	Greenup County, Ky
1955, 65, 73	1:20000	Hancock County, Ky
1951, 59, 64, 72	1:20000	Hardin County, Ky
1951, 60, 66	1:20000	Jefferson County, Ky
1973	1:40000	Jefferson County, Ky
1959, 60, 65, 72	1:20000	Lewis County, Ky
1949, 57, 69	1:20000	Mason County, Ky
1951, 60, 66	1:20000	Meade County, Ky
1973	1:40000	Meade County, Ky
1949, 60, 67	1:20000	Pendleton County, Ky
1973	1:40000	Pendleton County, Ky
1950, 58, 71	1:20000	Adams County, Ohio
1950, 66, 71	1:20000	Brown County, Ohio
1950, 62, 68	1:20000	Clermont County, Ohio
1951, 58, 66	1:20000	Scioto County, Ohio
1974	1:40000	Scioto County, Ohio

TABLE III-1

MELDAHL POOL

Scientific Epithet	Common Name	Griffith	Wood	C. Rice	E. Rice
		Approximate ORM			
		412	412	428	429
Acer negundo	Boxelder	X	X		X
Acer rubrum	Red maple				
Acer saccharinum	Silver maple	X		*	X
Aesculus octandra	Yellow buckeye				
Asimina triloba	Papaw				
Carya ovata	Shagbark hickory		X		
Carya tomentosa	Mockernut hickory				
Catalpa speciosa	Catalpa				X
Celtis laevigata	Hackberry				
Cercis canadensis	Redbud		X		
Cornus florida	Dogwood				
Fraxinus americana	White ash		X		
Gleditsia triacanthos	Honey locust				
Juglans nigra	Black walnut				
Liquidambar styraciflua	Sweet gum				
Liriodendron tulipifera	Tulip poplar				
Morus rubra	Red mulberry				
Quercus alba	White oak				
Quercus borealis	Red oak				
Quercus macrocarpa	Bur oak				
Quercus montana	Chestnut oak				
Platanus occidentalis	Sycamore	X			
Populus deltoides	Cottonwood	X			
Prunus serotina	Black cherry	X			
Robinia pseudo-acacia	Black locust		X	*	X
Salix interior	Sandbar willow	X	X		
Sassafras albidum	Sassafras				
Ulmus americana	American elm		X		X
Trees per acre whenere determined				429	
Basal area (sq. ft. per acre)				115.1	
Ages of oldest trees in sample		24	99	-	18

X Trees noted in area, but not included in sample analysis.
* Trees present in sample analysis

TABLE III-2

CANNELTON POOL

Scientific Epithet	Common Name	McGehee 642	McGehee 668	Cox 670	Benner 683
		Approximate ORM			
Acer negundo	Boxelder				
Acer rubrum	Red maple				
Acer saccharinum	Silver maple	X		X	*
Aesculus octandra	Yellow buckeye			X	
Asimina triloba	Papaw				
Carya ovata	Shagbark hickory				
Carya tomentosa	Mockernut hickory				
Catalpa speciosa	Catalpa				
Celtis laevigata	Hackberry		*	X	
Cercis canadensis	Redbud				
Cornus florida	Dogwood				
Fraxinus americana	White ash				
Gleditsia triacanthos	Honey locust		*		
Juglans nigra	Black walnut				
Liquidambar styraciflua	Sweet gum				
Liriodendron tulipifera	Tulip poplar				
Morus rubra	Red mulberry		*		
Quercus alba	White oak				
Quercus borealis	Red oak				
Quercus macrocarpa	Bur oak				
Quercus montana	Chestnut oak				
Platanus occidentalis	Sycamore			X	
Populus deltoides	Cottonwood	X			*
Prunus serotina	Black cherry		*		
Robinia pseudo-acacia	Black locust		*		
Salix interior	Sandbar willow	*	X	X	
Sassafras albidum	Sassafras				
Ulmus americana	American elm		*		
Trees per acre whenere determined		301	348		618
Basal area (sq. ft. per acre)		75	300		947
Ages of oldest trees in sample		8	35	64	38

X Trees noted in area, but not included in sample analysis.
* Trees present in sample analysis

TABLE III-2 (CONT.)

CANNELTON POOL (CONT.)

Scientific Epithet	Common Name	Glenn	Glenn	Loesch	Leatherbury	Wagner-Bynon
		Approximate ORM				
		691	694	708	714	718
Acer negundo	Boxelder			X		*
Acer rubrum	Red maple			X		
Acer saccharinum	Silver maple					*
Aesculus octandra	Yellow buckeye					
Asimina triloba	Papaw			X		
Carya ovata	Shagbark hickory			X		*
Carya tomentosa	Mockernut hickory					*
Catalpa speciosa	Catalpa					
Celtis laevigata	Hackberry	X	X	X		*
Cercis canadensis	Redbud					X
Cornus florida	Dogwood					X
Fraxinus americana	White ash					
Gleditsia triacanthos	Honey locust	X				
Juglans nigra	Black walnut					
Liquidambar styraciflua	Sweet gum					
Liriodendron tulipifera	Tulip poplar	X				
Morus rubra	Red mulberry					
Quercus alba	White oak	X				*
Quercus borealis	Red oak					*
Quercus macrocarpa	Bur oak					*
Quercus montana	Chestnut oak	X				*
Platanus occidentalis	Sycamore		X	X		
Populus deltoides	Cottonwood			X		
Prunus serotina	Black cherry	X				
Robinia pseudo-acacia	Black locust	X		X		
Salix interior	Sandbar willow					
Sassafras albidum	Sassafras					*
Ulmus americana	American elm	X	*			*
Trees per acre whenere determined			673			265
Basal area (sq. ft. per acre)			637			264
Ages of oldest trees in sample			22	70		93

X Trees noted in area, but not included in sample analysis.
* Trees present in sample analysis

2. Site Specific Data.

a. 523E (Ethyl RICE) ORM 429.1-429.2

(1) Hydrology and Hydraulics.

(a) Flow velocity measurements were taken in the cross section at ORM 429.2 on 16 April 1977.

(b) Tow generated wave heights were measured at ORM 429.2 on 7 May 1977.

(c) Wind speeds were determined at ORM 429.1 on 7 May 1977.

(2) Vegetation. Quantitative and qualitative analyses were performed on 26 May 1977. A general survey was made on 9 May 1977.

(3) Soils and Geology. Eight disturbed samples were secured on 10 May 1977 at a single site representing an 18.0 ft high section. One undisturbed sample was secured 5.4 ft below nominal top of bank.

(4) Photo Interpretation. Aerial photographs of scale 1:6000 were taken 22 March and 12 May 1977.

(5) Refer to Plates 17 and 29.

b. 527E-1&2 (Eugene and Elizabeth POSTON) ORM 428.8-429.0

(1) Hydrology and Hydraulics. Flow velocity measurements were taken in the cross section at ORM 428.9 on 16 April 1977.

(2) Vegetation. Site surveys were conducted on 10 May and 26 May 1977, with aging of sample trees performed on 26 May 1977.

(3) Soils and Geology. Four disturbed samples were secured on 10 May 1977 at a single site representing an 8.0 ft high section.

(4) Photo Interpretation. Aerial photographs of scale 1:6000 were taken 22 March and 12 May 1977.

(5) Refer to Plates 16 and 30.

c. 533E-1&2 (Charles & Jean RICE) ORM 428.3-428.4

(1) Hydrology and Hydraulics. Flow velocity measurements were taken in the cross section at ORM 428.3 on 16 April 1977.

(2) Vegetation. Site surveys were conducted on 10 and 26 May 1977, with aging of sample trees performed on 26 May 1977 .

(3) Soils and Geology. Four disturbed samples were secured on 10 May 1977 at a single site representing a 10.4 ft high section.

(4) Photo Interpretation. Aerial photographs of scale 1:6000 were taken 22 March and 12 May 1977.

(5) Refer to Plates 16 and 31.

d. 1209E (Norman and Anna WOOD) ORM 412.8-412.9

(1) Hydrology and Hydraulics.

(a) Flow velocity measurements were taken in the cross section at ORM 412.8 on 17 April 1977.

(b) Tow generated wave heights and wind speeds were measured at ORM 412.6 on 7 May 1977.

(2) Vegetation. Site surveys were conducted on 10 and 26 May 1977, with aging of sample trees performed on 26 May 1977.

(3) Soils and Geology. Seven disturbed samples were secured on 10 May 1977 at a single site representing an 18.0 ft high section.

(4) Photo Interpretation. Aerial photographs of scale 1:6000 were taken 22 March and 12 May 1977.

(5) Refer to Plates 15 and 32.

e. 1301E (Donald and Mary McNELLY) ORM 412.2-412.6

(1) Hydrology and Hydraulics. Flow velocity measurements were taken in the cross section at ORM 412.4 on 17 April 1977.

(2) Vegetation. Site surveys were conducted on 10 and 26 May 1977.

(3) Soils and Geology. Thirteen disturbed samples were secured on 11 May 1977 at a single site representing a 26.4 ft high section. One undisturbed sample was secured 1.4 ft below nominal top of bank.

(4) Photo Interpretation. Aerial photographs of scale 1:6000 were taken 22 March and 12 May 1977.

(5) Refer to Plates 14 and 33.

f. 1305E (James and Cheryl CHOUINARD) ORM 412.0-412.2

(1) Hydrology and Hydraulics. Flow velocity measurements were taken in the cross section at ORM 412.1 on 17 April 1977.

(2) Vegetation. Site surveys were conducted on 10 and 26 May 1977.

(3) Soils and Geology. Fourteen disturbed samples were secured. on 11 and 12 May 1977 representing a 23.9 ft high section at site "A" One undisturbed sample was secured 1.1 ft above the highest disturbed sample. Five disturbed samples were secured representing a 17.2 ft high section.

(4) Photo Interpretation. Aerial photographs of scale 1:6000 were taken 22 March and 12 May 1977.

(5) Refer to Plates 13 and 34.

g. 1307E (Jacob and Josephine SCHWAB) ORM 411.8-412.0

(1) Hydrology and Hydraulics. Flow velocity measurements were taken in the cross section at ORM 411.9 on 17 April 1977.

(2) Vegetation. Site surveys were conducted on 10 and 26 May 1977.

(3) Soils and Geology. Fifteen disturbed samples were secured on 12 May 1977 at a single site representing a 23.9 ft high section. One undisturbed sample was secured 4.0 ft below nominal top of bank.

(4) Photo Interpretation. Aerial photographs of scale 1:6000 were taken 22 March and 12 May 1977.

(5) Refer to Plates 13 and 35.

h. 1353E-1&2 (Bernard GRIFFITH) ORM 411.2-411.5

(1) Hydrology and Hydraulics.

(a) Flow velocity measurements were taken in the cross section at ORM 411.3 on 17 April 1977.

(b) Tow generated wave heights and wind speeds were measured at ORM 411.3 on 6 May 1977.

(2) Vegetation. Site surveys were conducted on 10 and 26 May 1977, with aging of selected trees performed on 26 May 1977.

(3) Soils and Geology. Eight disturbed samples were secured on 12 May 1977 at a single site representing a 13.4 ft high section.

(4) Photo Interpretation. Aerial photographs of scale 1:6000 were taken 22 March and 12 May 1977.

(5) Refer to Plates 12 and 36.

i. 2102E-1&2 (Beuford CUNNINGHAM) ORM 394.3-394.7

(1) Hydrology and Hydraulics.

(a) Flow velocity measurements were taken in the cross section at ORM 394.2 on 17 April 1977.

(b) Tow generated wave heights and wind speeds were measured at ORM 394.2 on 6 May 1977.

(2) Vegetation. A site survey was conducted on 10 May 1977.

(3) Soils and Geology. Twenty-nine disturbed samples were secured on 12 May 1977 at a single site representing a 29.6 ft high section. Three undisturbed samples were secured approximately 5.3 ft, 17.3 ft, and 25.4 ft. below nominal top of bank.

(4) Photo Interpretation. Aerial photographs of scale 1:6000 were taken 22 March and 12 May 1977.

(5) Refer to Plates 11 and 37.

j. 410E (George WAGNER) ORM 718.3

(1) Hydrology and Hydraulics. Flow velocity measurements were taken at ORM 718.0 on 15 April 1977 and 24 May 1977.

(2) Vegetation. Quantitative and qualitative analyses were performed on 24 May 1977. A general survey of the sites was conducted 9 May 1977.

(3) Soils and Geology. Thirteen disturbed samples were secured on 3 May 1977 at a single site at the Wagner property representing a 28.7 ft high section.

(4) Photo Interpretation. Aerial photographs of scale 1:6000 were taken Nov 1976, Feb 1977, and May 1977.

(5) Refer to Plates 26 and 38.

k. 640E (Henriella BYNON) ORM 717.9

(1) Hydrology and Hydraulics. Flow velocity measurements were taken at ORM 718.0 on 15 April 1977 and 24 May 1977.

(2) Vegetation. Quantitative and qualitative analyses were performed on 24 May 1977. A general survey of the sites was conducted 9 May 1977.

(3) Soils and Geology. Eleven disturbed samples were secured on 2 May 1977 at a single site at the Bynon property representing a 38.3 ft high section.

(4) Photo Interpretation. Aerial photographs of scale 1:6000 were taken 23 Nov 1976, 2 Feb 1977, and 9 May 1977.

(5) Refer to Plates 27 and 39.

l. 719E (Douglas LEATHERBURY) ORM 714.2-714.5

(1) Hydrology and Hydraulics.

(a) Flow velocity measurements were taken in the cross section at ORM 714.0 on 15 April 1977 and 24 May 1977.

(b) Tow generated wave heights and wind speeds were measured at ORM 714.0 on 1 May 1977.

(2) Vegetation. Site surveys were conducted on 9 and 24 May 1977.

(3) Soils and Geology. Ten disturbed samples were secured on 4 May 1977 at a single site representing a 10.4 ft high section. Two undisturbed samples were secured approximately 2.0 ft and 6.7 ft below nominal top of bank.

(4) Photo Interpretation. Aerial photographs of scale 1:6000 were taken 23 Nov 1976, 2 Feb 1977, and 9 May 1977.

(5) Refer to Plates 25 and 40.

m. 1301E-1&2 & 1318E (Earl LOESCH et ux) ORM 708.3-708.6

(1) Hydrology and Hydraulics.

(a) Flow velocity measurements were taken in the cross section at ORM 708.2 on 15 April 1977 and 24 May 1977.

(b) Tow generated wave heights and wind speeds were measured at ORM 708.1 on 1 May 1977.

(2) Vegetation. Site surveys were conducted on 9 and 24 May 1977, with aging of selected trees performed on 24 May 1977.

(3) Soils and Geology. Sixteen disturbed samples were secured on 2 May 1977 at a single site representing an 18.5 ft high section. One undisturbed sample was secured 12.2 ft below nominal top of bank.

(4) Photo Interpretation. Aerial photographs of scale 1:6000 were taken 23 Nov 1976, 2 Feb 1977, and 9 May 1977.

(5) Refer to Plates 24 and 41.

n. 2200E (Chester EATON & Gerald WILLIAMS) ORM 696.3-696.5

(1) Hydrology and Hydraulics.

(a) Flow velocity measurements were taken in the cross section at ORM 696.3 on 16 April 1977 and 25 May 1977.

(b) Tow generated wave heights and wind speeds were measured at ORM 696.3 on 1 May 1977.

(2) Vegetation. A site survey was conducted 9 May 1977.

(3) Soils and Geology. Nineteen disturbed samples were secured 4 May 1977 at a single site representing a 23.6 ft high section. One undisturbed sample was secured 16.8 ft below nominal top of bank.

(4) Photo Interpretation. Aerial photographs of scale 1:6000 were taken 23 Nov 1976, 2 Feb 1977, and 9 May 1977.

(5) Refer to Plates 23 and 42.

o. 2215E, 2218E, & 2410E (Billy C. GLENN) ORM 692.5-694.2

(1) Hydrology and Hydraulics.

(a) Flow velocity measurements were taken in the cross section at ORM 692.3 and ORM 693.25 on 16 April 1977.

(b) Tow generated wave heights and wind speeds were measured at ORM 692.3 and ORM 693.25 on 2 and 3 May 1977, respectively.

(2) Vegetation. A general survey of the sites was conducted on 9 May 1977. Qualitative and quantitative analyses of vegetation and aging of selected trees were performed on 23 May 1977.

(3) Soils and Geology. Twenty-five disturbed samples were secured on 5 May 1977 representing a 30.4 ft high section. One undisturbed sample was secured 17.7 ft below nominal top of bank. Twenty-one disturbed samples were secured representing a 19.5 ft high section. One undisturbed sample was secured 17.2 ft below nominal top of bank. Two disturbed samples were secured just above and below the water's surface.

(4) Photo Interpretation. Aerial photographs of scale 1:6000 were taken 23 Nov 1976, 2 Feb 1977, and 9 May 1977.

(5) Refer to Plates 22 and 43.

p. 3015E (Clyde BENNER) ORM 683.3-684.0

(1) Hydrology and Hydraulics. Tow generated wave heights and wind speeds were measured at ORM 684.0 on 3 May 1977.

(2) Vegetation. A general site survey was conducted 9 May 1977. Qualitative and quantitative analyses of vegetation and aging of selected trees were performed 23 May 1977.

(3) Soils and Geology. Nine disturbed samples were secured at a single site on 3 May 1977 representing a 16.9 ft high section. One undisturbed sample was secured 5.7 ft below nominal top of bank.

(4) Photo Interpretation. Aerial photographs of scale 1:6000 were taken 23 Nov 1976, 2 Feb 1977, and 9 May 1977.

(5) Refer to Plates 21 and 44.

q. 3229E & 3238E (Nicholas PURCELL) Mill Creek, Ind.

(1) Hydrology and Hydraulics. No data developed.

(2) Vegetation. Site surveys were conducted 9 and 24 May 1977.

(3) Soils and Geology. Eleven disturbed samples were secured 4 May 1977 at a single site representing a 42.9 ft high section.

(4) Photo Interpretation. Aerial photographs of scale 1:6000 were taken 23 Nov 1976, 2 Feb 1977, and 9 May 1977.

(5) Refer to Plate 45.

r. 3703E (Ralph COX) ORM 669.8-670.2

(1) Hydrology and Hydraulics. No site specific data were developed.

(2) Vegetation. Site surveys were conducted 9 and 23 May 1977. Aging of selected trees was performed 23 May 1977.

(3) Soils and Geology. Twelve disturbed samples were secured at a single site on 4 May 1977, representing a 21.0 ft high section. One undisturbed sample was secured 9.4 ft below nominal top of bank.

(4) Photo Interpretation. Aerial photographs of scale 1:6000 were taken 23 Nov 1976, 2 Feb 1977, and 9 May 1977.

(5) Refer to Plates 20 and 46.

s. 3828E (John McGEHEE) ORM 668.3-668.6

(1) Hydrology and Hydraulics.

(a) Velocity measurements were made in the cross section at ORM 669.0 on 14 April 1977 and 23 May 1977.

(b) Tow wave height and wind speed measurements were made at ORM 669.0 on 4 May 1977.

(2) Vegetation. A general site survey was conducted 9 May 1977. Qualitative and quantitative analyses of vegetation and aging of selected trees were performed 23 May 1977.

(3) Soils and Geology. Fifteen disturbed samples were secured 29 April 1977 at a single site representing a 32.8 ft high section.

(4) Photo Interpretation. Aerial photographs of scale 1:6000 were taken 23 Nov 1976, 2 Feb 1977, and 9 May 1977.

(5) Refer to Plates 19 and 47.

t. 5018E (E. Davis McGEHEE) ORM 641.8-642.2

(1) Hydrology and Hydraulics.

(a) Velocity measurements were made in the cross section at ORM 641.4 on 14 April 1977 and 23 May 1977.

(b) Tow wave heights and wind speeds were measured at ORM 641.5 on 4 May 1977

(2) Vegetation. A general site survey was conducted 9 May 1977. Qualitative and quantitative analyses of vegetation and aging of selected trees were performed 23 May 1977.

(3) Soils and Geology. Twenty-eight disturbed samples were secured on 27 and 28 Apr 1977 at a single site on Tract 5018E representing a 23.4 ft high section. Two undisturbed samples were secured 9.3 ft and 15.8 ft below nominal top of bank.

(4) Photo Interpretation. Aerial photography of scale 1:6000 was taken 23 Nov 1976, 2 Feb 1977, and 9 May 1977.

(5) Refer to Plates 18 and 48.

u. 5101E, 5112E (John McGEHEE) ORM 639.5-641.1

(1) Hydrology and Hydraulics.

(a) Velocity measurements were made in the cross section at ORM 641.4 on 14 April 1977 and 23 May 1977.

(b) Tow wave heights and wind speeds were measured at ORM 641.5 on 4 May 1977

(2) Vegetation. A general site survey was conducted 9 May 77. Qualitative and quantitative analyses of vegetation and aging of selected trees were performed 23 May 77.

(3) Soils and Geology. Twenty-two disturbed samples were secured on 28 and 29 April 1977, representing a 26.7 ft high section. Two undisturbed samples were secured 16.7 ft and 33.7 ft below nominal top of bank at this location. An additional undisturbed sample was

secured approximately 350 ft. downstream, again 33.7 ft below the referenced top of bank. Thirteen disturbed samples were secured, representing a 27.5 ft high section. One undisturbed sample was secured 5.3 ft below the nominal top of bank.

(4) Photo Interpretation. Aerial photography of scale 1:6000 was taken 23 Nov 76, 2 Feb 77, and 9 May 77.

(5) Refer to Plates 18 and 49.

v. (DICKENSON) ORM 724.6

(1) Hydrology and Hydraulics.

(a) Velocity measurements were made in the cross section at ORM 724.4 on 15 Apr 77 and 24 May 77.

(b) Tow wave heights and wind speeds were measured at ORM 724.5 on 30 Apr 77.

(2) Vegetation. A general site survey was conducted 9 May 1977.

(3) Soils and Geology. Twenty-four disturbed samples were secured 3 May 1977 at a single site representing a 22.2 ft high section. One undisturbed sample was secured 8.8 ft below nominal top of bank.

(4) Photo Intrepretation. Aerial photography of scale 1:6000 was taken 23 Nov 76, 2 Feb 77, and 9 May 77.

(5) Refer to Plates 28 and 50.

IV. APPLICATION OF DATA TO SPECIFIC SITES.

1. Tract 523E Ethyl RICE ORM 429.1 - 429.2

a. Hydraulics and Hydrology.

(1) Velocities. The maximum velocity measured at ORM 419.1 on 16 April 1977 was 2.5 ft per sec with a top width of 2,260 ft, a thalweg depth of 37 ft, and stage 0.27 ft above normal pool.

(2) Waves.

(a) The fetch region generating wind waves for this property extends from E to SSW with a maximum effective fetch length of 1.4 miles from the E.

(b) For this property prevailing wind direction within the fetch region is from the SW.

(c) Tow wave height measurements at ORM 429.1 on 7 May 1977 show maximum wave heights ranging from 0.41 to 1.00 ft.

(3) Sailing and Mooring. The new sailing line is closer to the bank due to the inundation of a bar.

(4) Shoreline Features. A boat dock is located on the bank at ORM 430.2.

(5) River Flows and Stages.

(a) The natural OHW at ORM 429.1 was elev 477.0; the modified OHW was computed to be elev 485.8.

(b) The 24-ft raising of the normal pool from 461.0 to 485.0 has reduced the range of pool fluctuations.

(6) Material Removal.

(a) No maintenance dredging has been performed at this site.

(b) Commercial dredging was performed from 1970-1976 between ORM 427.5 and 430.0 on the opposite bank.

b. Vegetation and Clearing.

(1) Bulldozing has recently disturbed the bank, with access to the river being excavated in addition to a 20-ft wide clearing through the trees on the slope leading to the high bank. Along the immediate bank were box elder, black locust, and catalpa, with silver maple, black locust and American elm being encountered further back from the river. Some root exposure was noted along the water's edge.

(2) Clearing by the Corps removed larger vegetation from the low banks prior to raising the pool.

c. Soils and Geology. Investigations were conducted at this tract located on the Ohio River and tributary streams on 10 May 1977. Ohio River stage this date was elev 485.6. Recent slumpage had exposed scarps within the banks and benching had occurred in failure debris. Accumulation of drift was noted at and in tributary streams and along Augusta Bar. Bank erosion was noted along the tributary stream. Scarps, excavations and augering encountered alluvium: moist dark brown to brown silty clay with fine sand stringers.

d. Photo Interpretation Notes.

(1) Unstable Zones. The area appears to be unchanged throughout pre-Meldahl pool photography. Delta formations and small lateral changes below the mouths of tributaries indicate an environment favoring accretion rather than erosion. Only slight changes in the lower bank were noted from 1938 to 1959.

(2) Bank Changes. Prior to the impoundment of the river a large sand and gravel bar protected the bank during normal and low flows. When the Lock & Dam 34 pool was impounded, the bar was submerged. This impoundment-induced configuration remained fairly stable except for accretion which took place along the right bank in front of this tract. When the Meldahl pool was impounded in 1965, the bank configuration was changed by inundation of the lower terrace. The upper terrace, which had a considerably steeper slope, became the bank at the new normal pool.

The 1966, 1971, and 1977 photography shows very shallow water in front of the tract. This is the submerged low terrace which appears to support emergent aquatic vegetation as well as being a collection area for snags and other drift. Also this area is a protective barrier for the banks. At normal pool, most wave energy would be dissipated by the emergent vegetation growing in the shallow water and by drift accumulations. The presence of the emergent vegetation indicates that the bottom conditions were stable for plant growth and reproduction; therefore, this is possibly an area of sediment accumulation.

The removal of trees below the first terrace may have had a detrimental effect. The trees were removed prior to the 1938 photography and the slope thereafter kept in grass. The grass slope was noted to be more susceptible to bank erosion than adjacent properties with original tree cover.

Farming practice since the earliest photography shows cultivation near the top of bank. This practice has also contributed to bank changes by exposing the soil to erosion by rainfall and runoff through the winter and early spring.

Since the pool was raised, a small recreational area was developed upstream of this tract. The USGS Felicity OH/KY Quadrangle shows several campsites in the immediate area.

e. Summary. A minor tributary stream, which may cause saturation of bank materials, is located at this site. Additionally, submergence of a bar deposit immediately adjacent to the riverbank at this site appears to have had an effect on bank erosion. Previously, river traffic could not navigate close to the banks during slackwater periods because of the presence of the bar. After impoundment of the Meldahl pool, river traffic could pass relatively close to the banks at this point and could possibly be a source of erosive wave action. These factors act in addition to the significant erosive mechanisms of mass instability associated with saturation of bank materials followed by rapid fall in river elevation, and piping and undermining.

f. Conclusions. Bank erosion at this site would have occurred by natural phenomena without the construction of the navigation structures and the impoundment of a permanent pool. Of the natural erosion-causing phenomena, drawdown-related bank failure and piping with resulting undermining are of major significance. The stabilization of stages and flows provided by Corps of Engineers' projects tends to reduce these rapid drawdown conditions. However, the interaction of several factors renders it impossible to predict erosion or accretion rates.

g. Refer to Plates 9, 17, 29 and A-3; and Figure B-1-1.

2. Tract 527E - 1&2 Eugene and Elizabeth POSTON ORM 428.8-429.0

a. Hydraulics and Hydrology.

(1) Velocities. The maximum velocity measured on 16 Apr 1977 was 2.7 ft per sec with a top width of 2,340 ft, a thalweg depth of 36 ft, and stage 0.20 ft above normal pool. These data are from measurements at ORM 428.9.

(2) Waves.

(a) The fetch region generating wind waves for this property extends from E to SW with a maximum effective fetch length of 1.4 miles from the E.

(b) For this property prevailing wind direction within the fetch region is from the SSW.

(c) Tow wave height determinations at ORM 429.1 on 7 May 1977 show maximum wave heights ranging from 0.41 to 1.00 ft.

(3) Sailing and Mooring. The new sailing line is closer to the bank due to inundation of a bar.

(4) Shoreline Features. A boat dock is located at ORM 430.2.

(5) River Flows and Stages.

(a) The natural OHW at ORM 428.9 was elev 477.1; the modified OHW was computed to be elev 485.8.

(b) The 24-ft raising of the normal pool from 461.0 to 485.0 has reduced the range of pool fluctuations.

(6) Material Removal.

(a) No maintenance dredging has been performed at this site.

(b) Commercial dredging was performed from 1970-1976 between ORM 427.5-430.0 on the opposite shore.

b. Vegetation and Clearing.

(1) A steep bank leads almost directly from the water to a flat terrace with a dense grove of silver maple and black locust. Some roots were exposed, but where observations were made, no trees had toppled into the river. Trees located near the shore included silver maple, box elder, American elm, and catalpa.

(2) Clearing was performed by the Corps at this site prior to raising the pool.

c. Soils and Geology. Investigations were conducted at this tract located on the Ohio River and tributary stream on 10 May 1977. Ohio River stage this date was 485.6. Recent slumpage scarps within

the banks and benching in failure debris had occurred. Accumulation of drift was noted at the tributary stream and along Augusta Bar. Scarps, excavations and augering encountered alluvium: moist dark brown to brown silty clay with fine sand stringers.

d. Photo Interpretation Notes.

(1) Unstable Zones. The area appears to be unchanged throughout pre-Meldahl pool photography. Delta formations and small lateral changes below the mouths of tributaries indicate an environment favoring accretion rather than erosion. Only slight changes in the lower bank were noted from 1938 to 1959.

(2) Bank Changes. Prior to the impoundment of the river a large gravel bar protected the bank during normal and low flows. When the Lock & Dam 34 pool was impounded, the bar was submerged. This impoundment-induced configuration remained fairly stable except for accretion which took place along the right bank in front of this tract. When the Meldahl pool was impounded in 1965, the bank configuration was changed by inundation of the lower terrace. The upper terrace, which had a considerably steeper slope, became the bank at normal pool.

The 1966, 1971, and 1977 photography shows very shallow water in front of the tract. This is the submerged low terrace which appears to support emergent aquatic vegetation as well as being a collection area for snags and other drift. Also this area is a protective barrier for the banks. At normal pool, most wave energy would be dissipated by the emergent vegetation growing in the shallow water and by drift accumulations. The presence of the emergent vegetation indicates that the bottom conditions were stable for plant growth and reproduction; therefore, this is possibly an area of sediment accumulation.

The removal of trees below the first terrace may have had a detrimental effect. The trees were removed prior to the 1938 photography and the slope thereafter kept in grass. The grass slope was noted to be more susceptible to bank erosion than adjacent properties with original tree cover.

Farming practice since the earliest photography shows cultivation near the top of bank. This practice has also contributed to bank changes by exposing the soil to erosion by rainfall and runoff through the winter and early spring.

Since the pool was raised, a small recreational area was developed upstream of this tract. The USGS Felicity OH/KY Quadrangle shows several campsites in the immediate area.

e. Summary. Removal of the protective capacity of a bar deposit immediately adjacent to the riverbank at this site appears to have had an effect on potential bank erosion. Previously, river traffic could not navigate close to the banks during slackwater periods because of the presence of the bar. After impoundment of the Meldahl pool, river traffic could pass relatively close to the banks at this point and could possibly be a source of erosive wave action. Additionally, a minor tributary stream which causes saturation of bank materials with possible consequent erosion is located at this site. These factors act in addition to the significant erosion mechanisms of mass instability associated with saturation of bank materials followed by rapid fall in river elevation, and piping and undermining.

f. Conclusions. Bank erosion at this site would have occurred by natural phenomena without the construction of the navigation structures and the impoundment of a permanent pool. Of the natural erosion-causing phenomena, saturation of bank materials and rapid fall of river and piping and undermining are of major significance. The stabilization of stages and flows provided by Corps of Engineers' projects tends to reduce rapid drawdown. However, the interaction of several factors renders it impossible to predict erosion or accretion rates.

g. Refer to Plates 9, 16, 30 and A-4; and Figure B-1-2.

3. Tract 533E - 1&2. Charles and Jean RICE ORM 428.3 - 428.4

a. Hydraulics and Hydrology.

(1) Velocities. The maximum velocity measured at ORM 428.3 on 16 Apr 1977 was 2.1 ft per sec with a top width of 2,320 ft, a thalweg depth of 37 ft, and stage 0.26 ft above normal pool.

(2) Waves.

(a) The fetch region generating wind waves for this property extends from E to SW with a maximum effective fetch length of 0.73 mile from the E.

(b) For this property prevailing wind direction within the fetch region is from the SSW.

(c) Tow wave height measurements at ORM 429.1 on 7 May 1977 show maximum wave heights ranging from 0.41 to 1.00 ft.

(3) Sailing and Mooring. The new sailing line is closer to the bank due to the inundation of a bar.

(4) Shoreline Features. A recreational boat dock is located along the bank at ORM 430.2.

(5) River Flows and Stages.

(a) The natural OHW at ORM 428.4 was elev 477.5; the modified OHW was computed to be elev 486.0.

(b) The 24-ft raising of the normal pool from 461.0 to 485.0 has reduced the range of pool fluctuations.

(6) Material Removal.

(a) No maintenance dredging has been performed near this site.

(b) Commercial dredging was performed from 1970-1976 between ORM 427.5 and 430.0 along the opposite bank.

b. Vegetation and Clearing.

(1) A steep bank 4-5 ft high is adjacent to a flat terrace with a dense grove of silver maple and black locust. Some roots were exposed, but no trees were observed to have toppled into the river.

(2) Clearing was performed by the Corps at this site prior to raising the pool.

c. Soils and Geology. Investigations were conducted at this tract located on the Ohio River and tributary stream on 10 May 1977. Ohio River stage this date was elev 485.6. Recent slumpage had exposed scarps within the banks and benching had occurred in failure debris. Accumulation of drift was noted at tributary stream and along Augusta Bar. Scarps, excavations and augering encountered alluvium: moist dark brown to brown silty clay with fine sand stringers.

d. Photo Interpretation Notes.

(1) Unstable Zones. The area appears to be unchanged throughout the pre-Meldahl pool period photography. Delta formations and small lateral changes below the mouths of tributaries indicate an environment favoring accretion rather than erosion. Only slight changes in the lower bank were noted from 1938 to 1959.

(2) Bank Changes. Prior to the impoundment of the river, a large gravel bar protected the bank during normal and low flows. When the Lock & Dam 34 pool was impounded, the bar was submerged. This impoundment-induced configuration remained fairly stable except for accretion which took place along the right bank in front of this tract. When the Meldahl pool was impounded in 1965, the bank configuration was changed by inundation of the lower terrace. The upper terrace, which had a considerably steeper alope, became the bank at normal pool.

The 1966, 1971, and 1977 photography shows very shallow water in front of the tract. This is the submerged low terrace which appears to support emergent aquatic vegetation as well as being a collection area for snags and other drift. Also this area is a protective barrier for the banks. At normal pool, most wave energy would be dissipated by the emergent vegetation growing in shallow water and by drift accumulations. The presence of the emergent vegetation indicates that the bottom conditions were stable for plant growth and reproduction.

The removal of trees below the upper terrace may have had a detrimental effect. The trees were removed prior to the 1938 photography and the slope thereafter kept in grass. The grass slope was noted to be more susceptible to bank erosion than adjacent properties with original tree cover.

Farming practice since the earliest photography shows cultivation near to the top of bank. This practice has also contributed to bank changes by exposing the soil to erosion by rainfall and runoff through the winter and early spring. Since the pool was raised, a small recreational area was developed upstream of this tract. The USGS Felicity OH/KY Quadrangle shows several campsites in the immediate area.

e. Summary. Removal of the protective capacity of a bar deposit immediately adjacent to the riverbank at this site appears to have had an effect on the potential bank erosion. Previously, river traffic could not navigate close to the banks during slackwater periods because of the presence of the bar. After impoundment of the Meldahl pool, river traffic could pass relatively close to the banks at this point and could possibly be a source of wave action. A minor tributary stream which causes saturation of bank materials with possible consequent erosion is located at this site. Significant erosion mechanisms are mass instability associated with saturation of bank maerials followed by rapid fall in river elevations and piping and undermining.

f. Conclusions. Bank erosion at this site would have occurred by natural phenomena without the construction of the navigation structures and the impoundment of a permanent pool. Of the natural erosion-causing phenomena, saturation of bank materials and rapid drawdown, and piping with undermining are of major significance. The stabilization of stages and flows provided by Corps of Engineers' projects tends to reduce rapid drawdown. However, the interaction of several factors renders it impossible to predict erosion or accretion rates.

g. Refer to Plates 9, 16, 31 and A-5; and Figure B-1-3.

4. Tract 1209E Norman and Anna WOOD ORM 412.8 - 412.9

a. Hydraulics and Hydrology.

(1) Velocities. The maximum velocity measured at ORM 412.8 on 17 Apr 1977 was 2.0 ft per sec with a top width of 1,140 ft, a thalweg depth of 56 ft, and stage of 0.46 ft above normal pool.

(2) Waves.

(a) The fetch region generating wind waves for this property extend from SSE to WNW with a maximum effective fetch length of 1.09 miles from the SE.

(b) For this property, prevailing wind direction within the fetch region is from the SSW.

(c) Tow wave height measurements made at ORM 412.8 on 7 May 1977 show maximum wave heights ranging from 0.55 to 1.20 ft.

(3) Sailing and Mooring. There is a slight shift in sailing line away from the bank.

(4) Shoreline Features. There is a boat dock located on the bank at ORM 414.0.

(5) River Flows and Stages.

(a) The natural OHW at ORM 412.8 was computed to be elev 481.4; the modified OHW was computed to be elev 488.1.

(b) The 24-ft raising of the normal pool from 461.0 to 485.0 has reduced the range of pool fluctuations.

(6) Material Removal.

(a) No maintenance dredging has been performed at this site.

(b) A commercial permit was issued for dredging to be performed in the vicinity of ORM 415 from 1970 to 1976.

b. Vegetation and Clearing.

(1) The lower slope area contains young white ash, American elm, and black locust. A 20 to 25 ft reach of slope separates this area from the narrow band of trees containing some shagbark hickory of large size. The upper slope includes box elder and has been

recently cut for a utility easement. The easement separates the bank from another stand of hickory, willow, black cherry and redbud, presumably once contiguous with the bank stand. Workers were observed cutting trees and shrubs along the riverward margin of the easement and disposing of them over the bank.

(2) Clearing was performed by the Corps at this site prior to raising the pool.

c. Soils and Geology.

(1) Investigations were conducted at this tract located along the Ohio River and a tributary on 10 May 1977. Ohio River stage this date was approximately 485.9. Colluvium materials extending from rock outcrops above United States Highway 52 to the Ohio River evidenced historical and recent failures with benching in the toe of slide area. Rock fragments from colluvial materials are encountered in the tributary channels and the toe of slope area. Failure surfaces are within the damp colluvium and approximate to top of rock. These materials consist of moist, dark brown to yellow brown silty clay with trace of fine sand.

d. Photo Interpretation Notes.

(1) Landslide-related slope changes were noted at this site. In the 1977 photo two areas in the middle of the site exhibited indications of additional slope failures.

(2) Extent. From 1938 to 1949 lower bank changes could not be determined as a result of high water conditions; however, the upper bank exhibited no discernible change. From 1949 to 1957 the lower bank exhibited changes, while the upper bank did not.

(3) Rate of Change. It appears that toe of slide changes were more extensive on the upstream portion of the tract.

e. Summary. Instability of the riverbank materials was noted, but it was considered to be a result of creep or solifluction type sliding in residual soils derived from local bedrock (colluvium). These colluvial slide areas experienced movement which occurs over a very long period of time at a relatively slow rate, with isolated instances of more rapid movement during periods of saturation or under similar circumstances when the resistance of the materials to sliding is reduced. At this colluvial slide area, the instability of the banks is in no way associated with the presence of the river at a higher impoundment elevation.

f. Conclusions. Sliding of slope colluvium unrelated to project modified river conditions is of major erosion significance.

g. Refer to Plates 9, 15, 32 and A-6; and Figure B-1-4.

5. Tract 1301E Donald and Mary McNELLY ORM 412.2 - 412.6

a. Hydraulics and Hydrology

(1) Velocities. The maximum velocity measured on 17 Apr 1977 was 2.5 ft per sec with a top width of 1,630 ft, a thalweg depth of 51 ft, and stage 0.47 ft above normal pool.

(2) Waves.

(a) The fetch region generating wind waves for this property extends from SSW to NNW with a maximum effective fetch length of 1.27 miles from the S.

(b) For this property prevailing wind direction within the fetch region is from the SSW.

(c) Tow wave height measurements at ORM 412.8 on 7 May 1977 show maximum wave heights ranging from 0.55 to 1.20 ft.

(3) Sailing and Mooring. There has been a slight shift in sailing line away from the bank since impoundment of the Meldahl pool.

(4) Shoreline Features. There is a recreational boat dock located along the bank at ORM 414.0.

(5) River Flows and Stages.

(a) The natural OHW at ORM 412.4 was elev 486.1; the modified OHW was computed to be elev 489.1.

(b) The 24-ft raising of the normal pool from 461.0 to 485.0 has reduced the range of pool fluctuations.

(6) Material Removal.

(a) No maintenance dredging has been performed in the vicinity of this site.

(b) A commercial dredging permit was issued for 1970-1976 for the vicinity of ORM 415.0.

b. Vegetation and Clearing.

(1) The steep banks vary from bare to covered. Erosion is noted along the top bank, exposing roots of American elm, cottonwood, and silver maple. Shrub growth is well established in places and consists of willow thickets, isolated alder, and some grasses.

(2) Large trees were removed by Corps clearing operations prior to raising the pool.

c. Soils and Geology. Field investigations were conducted during 11 May 1977 at this tract located adjacent to several tributaries and the Ohio River. Recent slumpage exposed scarps were evident in alluvial materials along reaches of Ohio River bank. Bank erosion on tributaries occurred within the area of main stem confluence. Drainage control was not observed at this tract. Accumulation of drift was observed along these tributaries. Slumpage exposed and excavation and auger encountered alluvium generally consisting of moist brown silty clay with fine sand and clayey silt with fine sand stringers.

d. Photo Interpretation Notes.

(1) From 1938 to 1948, lower bank change could not be detected due to high water and tree cover; however, the upper bank evidenced discernible changes. From 1949 to 1957, the lower bank evidenced change while the upper bank exhibited no visible change during this period. From 1957 to 1965, the lower bank evidenced moderate changes along limited reaches. However, this bank change could not solely be attributed to any one factor, as the Meldahl pool was in place in March of 1965, and photos were taken in the fall of that year. There was no defined change detected within the bank during this time. From 1965 to 1977, the bank evidenced additional changes at specific locations.

(2) Significant Factors. The site is situated on the outside curve of the Ohio River, and there are indications that the river has cut into the right bank and land accretion has occurred at the left bank.

(3) Rate of Change. The reach of bank has exhibited detectable historic (1938-1977) erosion.

e. Summary. Some significant erosion by natural forces is evident at this location. The banks at this site are subject to mass instability associated with saturation of bank materials followed by rapid fall in river elevation. In addition, this tract is located on the outside of a bend where the river impinges directly on the banks and tractive forces would be at a maximum.

f. <u>Conclusions.</u> Bank erosion at this site would have occurred by natural phenomena without the construction of the navigation structures and the impoundment of a permanent pool. Of the natural erosion-causing phenomena, mass instability of saturated banks, rapid drawdown, and maximum tractice forces of flow velocities (as located on the outside of a bend) are of major significance. The stabilization of stages and flows provided by Corps of Engineers' projects tends to reduce rapid drawdown. However, the interaction of several factors renders it impossible to predict erosion or accretion rates.

g. Refer to Plates 9, 14, 33 and A-7; and Figure B-1-5.

6. Tract 1305E James and Cheryl CHOUINARD ORM 412.1 - 412.2

a. <u>Hydraulics and Hydrology.</u>

(1) <u>Velocities.</u> The maximum velocity measurement at ORM 412.1 on 17 April 1977 was 2.1 ft per sec with a top width of 1,760 ft, a thalweg depth of 52 ft, and stage 0.47 ft above normal pool.

(2) <u>Waves.</u>

(a) The fetch region generating wind waves for this property extends from SSE to NW with a maximum effective fetch length of 1.27 miles from the SSE.

(b) For this property, prevailing wind direction within the fetch region is from the SW.

(c) Tow wave height measurements at ORM 411.3 on 6 May 1977 show maximum wave heights ranging from 0.25 to 0.55 ft.

(3) <u>Sailing and Mooring.</u> There has been a slight shift in the sailing line away from the bank.

(4) <u>Shoreline Features.</u> A recreational boat dock is located along the bank at ORM 414.0.

(5) <u>River Flows and Stages.</u>

(a) The natural OHW at ORM 412.1 was elev 481.7; the modified OHW was computed to be elev 489.2.

(b) The 24-ft raising of the normal pool from 461.0 to 485.0 has reduced the range of pool fluctuations.

(6) Material Removal.

(a) No maintenance dredging has been performed near this site.

(b) Commercial dredging permits were issued for the vicinity of ORM 415 for 1970 to 1976.

b. Vegetation and Clearing.

(1) Most of the upper bank is cleared and used as lawn, except where trees and brush remain along the "peninsula" formed by Three-Mile Creek at the upstream end. The bank is generally steep and bare, including only isolated alder and willow. Banks along the creek appear stable with a shrub-herb cover.

(2) Clearing was performed by the Corps at this site prior to raising the pool.

c. Soils and Geology. Field investigations were conducted during 11 and 12 May 1977 at this tract located approximate to several tributaries including Three-Mile Creek and for tract-defined reaches of Ohio River bank. Recent slumpage exposed scarps were evident in alluvial materials along reaches of Ohio River bank. Bank erosion on tributaries occurred within areas of confluence with the Ohio River. Drainage control had not been effected at this tract and random material placements were noted as ineffective bank erosion protection measures. Bedded alluvial fine to medium sand was encountered near the top of bank. Accumulation of drift was observed along Three-Mile Creek. Slumpage exposed and excavation and auger encountered alluvium generally consisting of moist, brown silty clay with fine sand and clayey silt with fine sand stringers.

d. Photo Interpretation Notes.

(1) General. Bank changes were perceived on the right bank at Three-Mile Creek at its confluence with the Ohio River.

From 1938 to 1949 any lower Ohio River bank change could not be detected as a result of high water condition of the 1938 photos; however, the upper bank was exposed and during that period exhibited no visible changes.

Only minor bank line changes were noted between 1949 and 1977 except during the period from 1957 to 1965.

On the portion of Tract 1305-E which is on Three-Mile Creek, the first notable change in banks occurred between 1949 and 1957 and was apparently related to the construction of a new east-west highway through the area, and the attendant relocation of the mouth of the creek.

(2) Significant Factors Affecting the Ohio River Bank.

(a) The site is situated on an outside curve of the Ohio River and there are indications that the river has cut into the right bank and land accretion has occurred on the left bank.

(b) The mouth of Three-Mile Creek has been relocated.

(3) Significant Factors Affecting Three-Mile Creek.

(a) The absence of tree cover upstream of the mouth and on the right bank of the creek.

(b) The meandering bends of the creek.

(4) Rate of Change. As indicated, the bank has exhibited detectable historical (1938-1977) changes.

e. Summary. Erosion by natural forces is evident at this location. The banks at this site are subject to mass instability associated with saturation of bank materials followed by rapid fall in river elevation. In addition, this tract is located on the outside of a bend where the stream impinges directly on the banks and tractive forces would be at a maximum.

f. Conclusions. Bank erosion at this site would have occurred by natural phenomena without the construction of the navigation structures and the impoundment of a permanent pool. Of the natural erosion-causing phenomena, saturation of materials followed by rapid fall in river and tractive forces of flow velocities (as located on the outside of a bend) are of major significance. The stabilization of stages and flows provided by Corps of Engineers' projects tends to reduce rapid drawdown. However, the interaction of several factors renders it impossible to predict erosion or accretion rates.

g. Refer to Plates 9, 13, 34 and A-8; and Figure B-1-6.

7. Tract 1307E Jacob and Josephine SCHWAB ORM 411.8 - 412.1

a. Hydraulics and Hydrology.

(1) Velocities. The maximum velocity measured at ORM 411.9 on 17 April 1977 was 2.6 ft per sec with a top width of 1,670 ft and a thalweg depth of 45 ft and stage at 0.47 ft above normal pool.

(2) Waves.

(a) No wind-generated wave studies were made at this site.

(b) Tow wave height measurements made at ORM 411.3 on 6 May 1977 show maximum wave heights ranging from 0.25 to 0.55 ft.

(3) Sailing and Mooring. There is a slight shift in the sailing line away from the bank since the impoundment of the Meldahl pool.

(4) Shoreline Features. There is a recreational boat dock located on the bank at ORM 414.

(5) River Flows and Stages.

(a) The natural OHW at ORM 411.9 was elev 481.7; the modified OHW was computed to be elev 488.3.

(b) The 24-ft raising of the normal pool from 461.0 to 485.0 has reduced the range of pool fluctuations.

(6) Material Removal.

(a) No maintenance dredging was performed at this site.

(b) Commercial dredging permits were issued in the vicinity of ORM 415.0 for 1970-1976.

b. Vegetation and Clearing.

(1) These banks vary in regards to vegetative cover from willow thickets to isolated shrub stands and grasses on slump benches.

(2) The Three-Mile Creek bank is densely wooded with young cottonwood, sycamore, birch, silver maple, American elm, and red maple.

(3) Clearing was performed at this site by the Corps prior to raising the pool. Evidence of clearing within Three-Mile Creek has been masked by new growth.

c. Soils and Geology. Field investigations were conducted on 12 May 1977 at this tract located approximate to several tributaries including Three-Mile Creek and for tract-defined reaches of Ohio River bank. Recent slumpage exposed scarps were evident in alluvial materials along reaches of Ohio River banks. Bank erosion on tributaries occurred within areas of confluence with the Ohio River. Drainage control was not observed at this tract and random material placement was noted as

ineffective bank erosion protection measures. Sediment plumes were noted. Accumulation of drift was observed along tributaries. Slumpage exposed and excavation and auger encountered alluvium generally consisting of moist brown silty clay with fine sand and clayey silt with fine sand stringers. Granular materials were being extracted and processed at an excavation approximate to Three-Mile Creek.

d. Photo Interpretation Changes. Bank changes were perceived along this site on the right bank of the Ohio River and on the left bank of Three-Mile Creek at its confluence with the Ohio River.

From 1938 to 1949 any change within the lower bank of the Ohio River could not be detected as a result of high water condition of the 1938 photos; however, the upper bank was visible and exhibited no discernible changes. Only minor bank line changes were noted between 1949 and 1977 except during the period from 1957 to 1965.

The Three-Mile Creek relocation did not have any effect on site portions of the creek. Between 1957 and 1965 there were considerable location specific bank changes.

Between 1965 and 1977 no changes were discerned in the banks within those portions of the site on Three-Mile Creek. However, indications of bank erosion were apparent in the 1977 photos.

Other factors which could have affected these drawdown-related bank changes are: (1) erodible clayey silts and silty clay alluvium; (2) that the tract is situated on the beginning of the outside curve of the Ohio River and there is visual evidence that the river has cut into the right bank and land accretion has occurred on the left bank; (3) the absence of trees along the low bank after 1965; and (4) the relocation of the mouth of Three-Mile Creek.

Other factors which could have affected the bank changes on several portions of Three-Mile Creek are: (1) the absence of tree cover upstream of the mouth and on the right bank of the creek; and (2) the meandering bends of the creek.

This reach of bank has not exhibited detectable historical (1938-1977) changes.

e. Summary. Some erosion by natural forces is evident at this location. The banks at this site are subject to mass instability associated with saturation of bank materials followed by rapid fall in river elevation. In addition, this tract is located on the outside of a bend where the stream impinges directly on the banks and tractive forces would be at a maximum.

f. Conclusions. Bank erosion at this site would have occurred by natural phenomena without the construction of the navigation structures and the impoundment of a permanent pool. Of the natural erosion-causing phenomena, saturation of materials followed by rapid fall in river stage and maximum tractive forces of flow velocities (as located on the outside of a bend) are of major significance. The stabilization of stages and flows provided by Corps of Engineers' projects tends to reduce rapid drawdown. However, the interaction of several factors renders it impossible to predict erosion or accretion rates.

g. Refer to Plates 9, 13, 35 and A-9; and Figure B-1-7.

8. Tracts 1353E - 1&2 Bernard GRIFFITH ORM 411.2 - 411.5

a. Hydraulics and Hydrology.

(1) Velocities. The maximum velocity measured at ORM 411.3 on 17 April 1977 was 1.7 ft per sec with a top width of 1,530 ft, and a thalweg depth of 49 ft at stage 0.48 ft above normal pool.

(2) Waves.

(a) The fetch region generating wind waves for this property extends from S to NW with a maximum effective fetch length of 0.84 mile from the NW direction.

(b) For this property prevailing wind direction within the fetch region is from the SSW.

(c) Tow wave height measurements made at ORM 411.3 on 6 May 1977 show maximum wave heights ranging from 0.25 to 0.55 ft.

(3) Sailing and Mooring. No change in sailing line has occurred.

(4) Shoreline Features. A boat dock is located on the bank at ORM 414.0.

(5) River Flows and Stages.

(a) The natural OHW at ORM 411.3 was elev 481.8; the modified OHW was computed to be elev 488.3.

(b) The 24-ft raising of the normal pool from 461.0 to 485.0 has reduced the range of pool fluctuations.

(6) Material Removal.

(a) No maintenance dredging was performed in the vicinity of this site.

(b) In the vicinity of ORM 415 commercial dredging was performed from 1970-1976.

b. Vegetation and Clearing.

(1) A narrow lower slope with sand bar willow saplings and alder extends to the bank above which there is a narrow band of trees. including black cherry, hackberry, silver maple, and box elder. Behind this bank is a mowed strip separating a stand of trees similar to those near the river. A wet swale near the water contained willow, cottonwood, and sycamore.

(2) Clearing was performed at this site by the Corps prior to raising the pool.

c. Soils and Geology. Field investigations were conducted during 12 May 1977 at these tracts located approximate to several tributaries including Three-Mile Creek and a tract-defined reach of Ohio River bank. A recent bench was evident in alluvial materials along the Ohio River bank. Accumulation of drift was observed along tributaries. Slumpage exposed and excavation and auger encountered alluvium generally consisting of moist brown silty clay with fine sand and clayey silt with fine sand stringers. Granular materials were being extracted and processed at an excavation approximate to Three-Mile Creek.

d. Photo Interpretation Notes.

(1) General. Changes were perceived along the right bank of the Ohio River, but none were discerned on the banks of Three-Mile Creek.

From 1949 to 1957 no visible bank change was discernible along that portion of Three-Mile Creek within the site. During the same period, no discernible bank changes were noted on the Ohio River portion of site

Between 1965 and 1977 the lower portion of the Ohio River bank evidenced slight changes at specific locations, with no detectable change in the upper portion of the bank.

(2) Significant Factors. Factors which could have affected bank changes are: (1) the slumpage-susceptible and easily erodible silty sands, clayey silts, and silty clay alluvium within both Three-Mile Creek and Ohio River bank areas; (2) the site location on the outside of a bend of the Ohio River; and (3) the natural meandering of Three-Mile Creek.

(3) Rate of Change. As indicated, the top of the upper bank at this site has not exhibited any notable historical (1938-1977) change while the top of the low bank had evidenced slight changes.

e. Summary. Relatively negligible erosional activity is taking place at this location.

f. Conclusions. Bank erosion at this site would have occurred by natural phenomena without the construction of the navigation structures and the impoundment of a permanent pool. However, this site is considered to be in a condition of near stability. The stabilization of stages and flows provided by Corps of Engineers' projects tends to reduce rapid drawdown. However, the interaction of several factors renders it impossible to predict erosion or accretion rates.

g. Refer to Plates 9, 12, 36 and A-10; and Figure B-1-8.

9. Tracts 2102E - 1&2 Beuford CUNNINGHAM ORM 394.3 - 394.7

a. Hydraulics and Hydrology.

(1) Velocities. The maximum velocity measured at ORM 394.2 on 17 April 1977 was 2.1 ft per sec with a top width of 1,700 ft, a thalweg depth of 34 ft, and stage 0.58 ft above normal pool.

(2) Waves.

(a) The fetch region for wind waves at this property extends from NE to NW with a maximum effective fetch length of 0.98 mile from the NE.

(b) For this property the prevailing wind direction within the fetch region is from the NE.

(c) Tow wave height measurements at ORM 394.5 on 6 May 1977 show maximum wave heights ranging from 0.2 to 0.9 ft.

(3) Sailing and Mooring. There has been a slight shift in the sailing line away from the Kentucky bank. Project navigation depth is available between Manchester Islands #1 and #2 since the impoundment of Meldahl pool.

(4) Shoreline Features. A river terminal is located at mile 397 on the bank opposite. A boat launching ramp is located in the vicinity of ORM 395.5 on the Ohio bank.

(5) River Flows and Stages.

(a) The natural OHW at ORM 394.4 was elev 485.8; the modified OHW was computed to be elev 490.9.

(b) The 17-foot raising of the normal pool from 468.0 to 485.0 has reduced the range of pool fluctuations.

(6) Material Removal.

(a) Maintenance dredging was performed at Manchester Island between 1942-1961.

(b) Commercial dredging permits were issued in the vicinity of ORM 398 for 1970-1976.

b. Vegetation and Clearing

(1) A wide sparsely vegetated toe of slope area with clumps of horsetail, Virginia creeper, poison ivy, and grasses was noted as merging with a lower bank of similar, but more evenly distributed cover. Upper banks are wooded, mostly in silver maple and American elm. Some toppling was evident, especially toward the downstream end where the vegetation extends closer to the water.

(2) Clearing was performed by the Corps at this site prior to raising the pool.

c. Soils and Geology.

(1) Investigations were conducted at this tract located along the Ohio River, together with a tributary stream area, on 12 May 1977. River stage was approximately elev 486.0. Banks evidenced gently sloping lower reaches and moderate to steeply sloping upper reaches.

Recently deposited dessication-cracked gray organic silty clay was encountered within the lower reach of bank. Upper slope materials consisted of alluvial, moist to damp, dark brown to brown silty clay with fine sand and clayey sandy silt. Commercial dredging of granular materials was being conducted within the Ohio River approximately 2,500 ft downstream of this tract.

Of particular interest was a stratum of recently deposited silt located about elev 498 and noted along a low terrace near both the upstream and downstream property limits.

(2) Significant causative factors for the moderate upper bank erosion conditions noted at this tract are rapid drawdown conditions and waves at and most significantly above normal pool.

d. Photo Interpretation Notes.

(1) Location, Type, Extent. An examination of the 22 March 1977 (1:4,800) photography revealed that bank changes were discernible at least 6,000 ft. upstream of the site. In the downstream direction changes end abruptly at the Tract boundary. Downstream of this tract changes in slopes extend to the Chesapeake and Ohio Railroad fill. The change in slope approximate to the railroad fill was in the 1959 photography. Bank changes had occurred at the site and along the bank upstream prior to the 1971 photography and appeared to extend further upstream when photos obtained during 1977 were utilized.

Another bank change was at the upstream ends of both channel islands. Beginning at the nose of each island, changes occurred downstream along the left bank for about 1,000 feet and then abruptly ended. These changes were not discerned until the 1971 photography.

(2) Significant Factors. There are several factors of varying significance that could contribute to these changes.

(a) Vegetation. The bank tree cover in the 1938 photography appears to be younger than might be expected. The preliminary indication is that the land along the banks was originally more extensively farmed but during the 1930's was allowed to revert to old-fields growth. The photography from 1971 to 1977 indicates a progressive loss of bank vegetation. Some large trees were lying in the river at the base of the slope along with other debris.

(b) Channel Geometry. Because of the relatively narrow width along the Cunningham property, the bank could be subject to higher velocities during floods than the bank in the wider cross sections downstream. The situation where erosion diminished in the wider channel cross sections where flood flow velocities would be less makes this consideration a possibility.

The changes along the upstream end of channel islands could also occur during flood periods; however, erosion-related changes would not necessarily be restricted to only one side as in the case of the Manchester islands.

Considering the general pattern of bank changes along 5- to 6-mile reach of river channel, geometry does not seem to be a dominant factor.

(c) Sailing Line. Another possible factor resulting in bank changes at this site would be waves generated by towboats. The sailing line on the January 1977 navigation charts is located slightly to the right of mid-channel, but because a narrow passage exists through this reach of the river the left bank could still be subject to significant wave action. The sailing line proceeds around both islands, through the left channel and has been located here since at least 1913.

(3) Rate of Change. The lower alluvial terrace has changed to a moderate extent since 1938. The upper terrace does not appear to have experienced any changes to date. It was difficult to discern changes between 1971 and 1977 along top of bank except upstream of the site. It would seem that the bank at the site has changed during the interval between 1959 and 1971.

e. Summary. Localized piping and instability of materials associated with sequences of high water and rapid fall in river level were found at this site, although erosion-related activities could have been triggered by localized grain-by-grain removal through wave activity.

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f. Conclusions. Bank erosion at this site would have occurred by natural phenomena without the construction of the navigation structures and the impoundment of a permanent pool. Of the natural erosion-causing phenomena, saturation of bank materials and rapid fall in river stages and localized piping of materials are of major significance. The stabilization of stages and flows provided by Corps of Engineers' projects tends to reduce rapid drawdown. However, the interaction of several factors renders it impossible to predict erosion or accretion rates.

g. Refer to Plates 9, 11, 37 and A-11; and Figure B-1-9.

10. Tract 410E George WAGNER ORM 718.3

a. Hydraulics and Hydrology.

(1) Velocities. The maximum velocity measured at ORM 718.0 on 15 April 1977 was 4.5 ft per sec with a top width of 1,312 ft, a thalweg depth of 76 ft, and stage 0.6 ft above normal pool.

(2) Waves.

(a) The effective wind wave fetch region for this property extends from ESE to WSW with a maximum effective fetch length of 0.90 mile from the WSW.

(b) For this property the prevailing wind direction within the fetch region is from the SW.

(c) Wave height measurements were performed in the vicinity of this site at ORM 718.1.

(3) Sailing and Mooring. The sailing line has shifted towards the bank upstream of the property since the pool impoundment. Federal emergency mooring buoys are located at ORM 719.8.

(4) Shoreline Features. A marina is located at ORM 719.1 along the bank.

(5) River Flows and Stages.

(a) The natural OHW at ORM 718.3 was elev. 377.4; the modified OHW was computed to be elev. 383.4 for the 383 normal pool and 386.3 for the 386 normal pool.

(b) The 25-ft raising of the normal pool at these tracts from 358.0 to 383.0 has reduced the range of pool fluctuations.

(6) Material Removal. No maintenance dredging has been performed in the vicinity of this site. No specific information is available regarding commercial dredging.

b. Vegetation and Clearing.

(1) Vegetation is indicative of the colluvial origin of these soils and includes oak, hickory, sweet gum, hackberry, black walnut, and sassafras. Elevations of some individual trees would indicate long-term sliding in this area.

(2) Clearing was performed at this site by the Corps prior to raising the pool.

c. Soils and Geology. Field investigations were conducted at this tract located along the Ohio River on 2 and 3 May 1977. Ohio River stage these dates was approximately 383.1. Slopes extending from rock outcrops above Indiana State Route 166 to the Ohio River evidenced both historical and recent failures with tension cracks, scarps and river-eroded toe of slide colluvial debris being noted. Failure surfaces are within the damp slide material and near top of rock. This material consists of gray to brown silty clay with fine to medium sand and rock fragments.

d. Photo Interpretation Notes.

(1) The slope approximate to Indiana Highway 166 showed changes between 1930 and 1977. The greatest change in slope was at approximately Ohio River Mile 718 which is the location of the greatest slide activity and is just upstream of the tract. Slope changes were noted between Ohio River Miles 718 and 719. Comparison of photos indicates that slope changes have been intermittent along this reach between 1970 and 1977.

(2) Significant Factors. There are indications that landslides have been active within this area since the 1930's. Ground photos taken of this area and on-site examination showed numerous scarps or breaks in the ground surface with exposed planes of slippage.

e. Summary. Instability of the slope materials was noted, but was considered to be a result of a creep or solifluction type sliding in residual soils derived from local bedrock (colluvium). These colluvial slide areas experienced movement which occurs over a very long period of time at a relatively slow rate, with isolated instances of more rapid movement during periods of saturation or under similar circumstances when the resistance of the materials to sliding is reduced. At this colluvial slide area, the instability of the slope is in no way associated with the presence of the river at a higher elevation after pool impoundment.

f. Conclusions. Sliding of slope colluvium unrelated to river conditions is of major significance.

g. Refer to Plates 7, 27, 38 and A-12; and Figure B-1-10.

11. Tract 640E Henriella BYNON ORM 717.9

a. Hydraulics and Hydrology.

(1) Velocities. The maximum velocity measured at ORM 718.0 on 15 April 1977 was 4.5 ft per sec with a top width of 1,330 ft and a thalweg depth of 75 ft at 0.6 ft above normal pool.

(2) Waves.

(a) The fetch region for wind waves for this property extends from SE to W with a maximum effective fetch length of 0.95 mile from the SE.

(b) Prevailing wind direction within the fetch region is from the SW.

(c) Wave height measurements were performed in the vicinity of this site at ORM 718.1.

(3) Sailing and Mooring. The sailing line has shifted towards the bank upstream of the property since the pool impoundment. Federal emergency mooring buoys are located at ORM 719.8.

(4) Shoreline Features. A marina is located at ORM 719.1 along the bank.

(5) River Flows and Stages.

(a) The natural OHW at ORM 717.9 was elev. 377.5; the modified OHW was computed to be elev. 383.5 for the 383 normal pool and 386.4 for the 386 normal pool.

(b) The 25-ft raising of the normal pool from 358 to 383 has reduced the range of pool fluctuations.

(6) Material Removal. No maintenance dredging has been performed in the vicinity; no specific information is available regarding commercial dredging.

b. Vegetation and Clearing.

(1) Vegetation is indicative of the colluvial origin of these soils and includes hickory, sweet gum, hackberry, black walnut,

and sassafras. Elevations of some individuals would indicate long-term sliding in this area.

(2) Clearing was performed by the Corps at this site prior to raising the pool.

c. Soils and Geology. Field investigations were conducted at these tracts located along the Ohio River on 2 May 1977. Ohio River stage these dates was approximately 383.1. Slopes extending from rock outcrops above Indiana State Route 166 to the Ohio River evidenced historical and recent failures with tension cracks, scarps, and river-eroded toe of slide colluvial debris being noted. Failure surfaces are within the damp slide debris and near top of rock. This material consists of gray to brown silty clay with fine to medium sand and rock fragments.

d. Photo Interpretation Notes.

(1) Slopes approximate to Indiana Highway 166 showed changes between 1930 and 1977. The greatest change is near the downstream end of the Tract-defined reach. Slope changes occur between Ohio River Miles 718 and 719. Comparison with the 1970 photo indicates that changes have been intermittent along this slope between 1970 and 1977.

(2) Significant Factors. There are indications that landslides have been active within this area since the 1930's. Ground photos taken of this area and on-site examination showed numerous scarps or breaks in the ground surface with exposed planes of slippage.

e. Summary. Instability of the slope materials was noted, but it was considered to be a result of a creep or solifluction type sliding in residual soils derived from local bedrock (colluvium). These colluvial slide areas experienced movement which occurs over a very long period of time at a relatively slow rate, with isolated instances of more rapid movement during periods of saturation or under similar circumstances when the resistance of the materials to sliding is reduced. At this colluvial slide area, the instability of the banks is in no way associated with the presence of the river at a higher elevation after pool impoundment.

f. Conclusions. Sliding of slope colluvium unrelated to river conditions is of major significance.

g. Refer to Plates 7, 26, 39 and A-13; and Figure B-1-12.

12. Tract 719E Douglas LEATHERBURY ORM 714.2-714.5

a. Hydraulic and Hydrology

(1) Velocities. The maximum velocity measured at ORM 714.0 on 15 April 1977 was 4.9 ft per sec with a top width of 1,570 ft and a thalweg depth of 68 ft and stage 1.0 ft above normal pool.

(2) Waves.

(a) The fetch region for wind waves at this property is from SW to N, maximum effective fetch length is 1.29 miles from the N.

(b) Prevailing wind direction within the fetch region at this property is from the SSW.

(c) Tow wave height measurements at ORM 714.0 on 1 May 1977 show maximum wave heights ranging from 0.2 to 0.75 ft.

(3) Sailing and Mooring. No change in sailing lines. Federal emergency mooring facilities are located at the bank at ORM 713.9.

(4) Shoreline Features . None are located in the vicinity of the site.

(5) River Flows and Stages.

(a) The natural OHW at ORM 714.4 was elev. 378.4; the modified OHW was computed to be elev. 384.0 for the 383 normal pool and 386.8 for the 386 normal pool.

(b) The 25-ft raising of the normal pool at this tract from 358 to 383 has reduced the range of pool fluctuations.

(6) Material Removal.

(a) Maintenance dredging was performed at ORM 716.3 (Hog Point bar) from 1934-1966.

(b) No specific data are available on commercial dredging.

b. Vegetation and Clearing.

(1) The flood plain is cultivated to the edge of the bank near the upstream end of the site. Little protective vegetation exists except near Pond Creek, where shrub willow and maple reach near the water.

(2) Most tree cover along the low bank was removed during the Corps' clearing operations. Large rootwads were also removed during clearing. The vegetation fringe that formerly existed was located below the ordinary high water line and would have died and toppled without clearing.

c. Soils and Geology. Investigations were conducted at this tract located along the Ohio River together with a tributary stream area on 4 May 1977. River stage this date was approximately elev. 384.0. Slumpage exposed alluvium consisted of fine sand pockets and moist dark brown to brown sandy silt with clay and horizons of silty clay with fine sand. Benches were noted within lower bank slumpage materials.

d. Photo Interpretation Notes.

(1) The bank showed perceptible changes between 1930 and 1977. Comparison of photographs obtained in February 1938, May 1971, and May 1977 indicates that the extent of these changes decreases within a 2000-ft reach downstream of the tract.

(2) Comparison of photographs May 1971 taken 2 months prior to the final pool rise and February 1938 shows definible bank change. Further comparison of May 1971 and May 1977 shows additional bank change after the impoundment of the Cannelton Pool.

(3) The May 1977 photography shows two mooring buoys approximately 2,500 ft upstream of the site. Commercial and recreational traffic near the bank at that point could result in wave affects.

(4) Farming practices on the site may have contributed to the bank erosion, since plowed areas were noted near the edge of bank. The 1930 through 21 May 1971 photographs show that the land in the Pond Run basin was also being farmed. Some bank change within Pond Run was perceived when comparing the 1930 and 1971 photography, but no additional bank change was noticed after the final pool rise. Since the Cannelton Lock and Dam was completed the Pond Run area has been allowed to succeed to brush and small tree vegetative cover.

(5) Another contributing factor to bank change may be the area topography.

e. Summary. Localized piping and instability of materials principally associated with sequences of highwater and rapid fall in pool level were noted at this site. Erosional activities could also have been triggered by localized grain by grain removal through wave activity.

f. Conclusions. Bank erosion at this site would have occurred by natural phenomena without the construction of the navigation structures and the impoundment of a permanent pool. Of the natural erosion-causing phenomena, piping with undermining , saturation of bank materials,

rapid fall of river, and wave action are of major significance. The stabilization of stages and flows provided by Corps of Engineers' projects tends to reduce rapid drawdown. However, the interaction of several factors renders it impossible to predict erosion or accretion rates.

g. Refer to Plates 7, 25, 40 and A-14; and Figure B-1-12.

13. Tract 1300E-1&2 Earl LOESCH ORM 708.3 to 708.6

a. Hydraulics and Hydrology.

(1) Velocities. The maximum velocity measured at ORM 708.2 on 15 April 1977 was 4.0 ft per sec with a top width of 2,480 ft and a thalweg depth of 47 ft at 1.7 ft above normal pool.

(2) Waves.

(a) The effective wind wave fetch region for this site extends from SSW to NNE, with maximum effective fetch length of 0.84 mile from the NE.

(b) For this property the prevailing wind direction within the fetch region is from the S.

(c) Tow wave height measurements at ORM 708.1 on 1 May 1977 show maximum wave heights from 0.2 to 0.7 ft.

(3) Sailing and Mooring. There has been change in sailing lines. Tows can navigate substantially closer to the bank during slack-water conditions since the submergence of a bar.

(4) Shoreline Facilities. None are located in the vicinity of the site.

(5) River Flows and Stages.

(a) The natural OHW at ORM 708.3 was elev. 380.0; the modified OHW was computed to be elev. 385.1 for the 383 normal pool and 387.7 for the 386 normal pool

(b) The 25-ft raising of the normal pool from 358.0 to 383.0 has reduced the range of pool fluctuations.

(6) Material Removal. Maintenance dredging was performed at Carter's Landing Bar (ORM 707.9) from 1934 to 1966. Spoil was placed on the Kentucky bank.

b. Vegetation and Clearing.

(1) Vegetation indicates a relatively stable bank, with good cover of grasses and herbs - upper elevations include mixed woods of box elder, red maple, pawpaw, hackberry, black walnut, and shagbark hickory - all species characteristic of well-drained soils.

(2) An American elm at the water surface was aged at 70 years. This area was within a slope area unsuitable for cultivation (slope of 16°), located between the cultivated flood plain and cultivated lower terrace.

(3) The existing "beach" extending into the river was a cultivated terrace in 1930 and 1938 and was reverting to other vegetation in 1967.

c. Soils and Geology. This tract was investigated on 2 May 1977 with the Ohio River stage at approximately elevation 383.4. Banks along the Ohio River evidenced steep scarps. The lower scarp was noted as continuing along the tract-defined reach and recent erosion-exposed alluvium consisted of moist brown to dark brown fine sandy clayey silt and silty fine sand stringers, with some clay and fine charcoal fragments. Benches were noted in lower bank debris. Drift accumulations and anchored stumps were observed within and at lower bank areas. Sediment plumes were evident. Cattle were observed grazing this property and watering on the beach. Related scarification of the beach surface by cattle was noted.

d. Photo Interpretation Notes. Changes in this area have been discerned along the right bank of the Ohio River, affecting the entire site except an area upstream of a north-south rural road and along an unnamed tributary which has no perceptible bank change.

e. Summary. Relatively minor erosion was noted as occurring. At this location, the pool inundated a shallow bar deposit allowing commercial and recreational vessels to navigate closer to the riverbanks than had been possible before the impoundment occurred.

f. Conclusions. Bank erosion at this site would have occurred by natural phenomena without the construction of the navigation structures and the impoundment of a permanent pool. Of the natural erosion-causing phenomena, saturation of bank materials and rapid fall of river, piping and undermining are of major significance. The stabilization of stages and flows provided by Corps of Engineers' projects tends to reduce rapid drawdown. However, the interaction of several factors renders it impossible to predict erosion or accretion rates.

g. Refer to Plates 7, 24, 41 and A-7; and Figure B-1-13.

14. Tract 2200E — Chester EATON and Gerald WILLIAMS — ORM 696.3 to 696.5

a. Hydraulics and Hydrology.

(1) Velocities. The maximum velocity measured at ORM 696.3 on 16 April 1977 was 3.5 ft per sec with a top width of 2,120 ft, a thalweg depth of 39 ft, and stage 3.9 ft above normal pool.

(2) Waves

(a) Wind wave fetch region for this property is from SSE to NNE with a maximum effective fetch length of 0.98 mile from the SE.

(b) For this property the prevailing wind direction within the fetch region is SE.

(c) Tow wave height measurements at ORM 696.3 on 1 May 1977 show maximum wave heights ranging from 0.25 to 0.75 ft.

(3) Sailing and Mooring. There are no changes in sailing line. No mooring facilities are located in the vicinity.

(4) Shoreline Features. None are located in the vicinity of this property.

(5) River Flows and Stages.

(a) The natural OHW at ORM 696.4 was elev. 383.3; the modified OHW was computed to be elev. 387.9 for the 383 normal pool and 389.9 for the 386 normal pool.

(b) The 16-ft raising of the normal pool from 367 to 383 has reduced the range of pool fluctuations.

(6) Material Removal. No maintenance dredging was performed in the vicinity of the site. No specific information regarding commercial dredging is available.

b. Vegetation and Clearing.

(1) Clearing to 386 ft. msl was accomplished by the Corps.

(2) Clearing was not a causative factor in the erosion at this site. All of the cleared vegetation would have died and toppled had it not been removed.

(3) Presently bank vegetation is established near Little Poison Creek (willow thickets).

c. Soils and Geology. Field investigations were conducted on 4 May 1977 at this tract located along the Ohio River approximately elevation 384.0. Tract reconnaissance was inclusive of the tributary Little Poison Creek and evidenced steep banks with numerous slumps which exposed moist brown silty clay, with fine sand, brown clayey silt with fine sand, clayey silty fine to medium sand. Dessication cracking in alluvium was noted. Considerable drift had accumulated in the lower bank areas.

d. Photo Interpretation Notes.

(1) Bank Changes. A zoom transfer scope was used to make a study of the change in bank areas between 1930 and 1977. Approximately 3,500 ft of shoreline was referenced from just south of Poison Creek to immediately north of Little Poison Creek. Drainways from a small farm pond located about 1,500 ft inland from the Ohio draining to Poison Creek were also discerned.

(2) There was no perceived change in the bank between 1930 and August 1967 with June 1938 photograph also being examined. Changes are discernible within the northern area of the tract in the 19 January 1971 photography. The January 1973 photography shows bank change all along the reach of tract north of Poison Creek. Bank changes vary in extent from perceptible at the northern boundary of the tract to no change south of Poison Creek. Changes have continued to May 1977 at an apparently diminishing rate.

(3) Prior to August 1967 there was no detectable change, but during the period August 1967 to June 1971 changes were noted.

(4) Comments regarding extent of bank changes after August 1967 are relevant to this tract only. For instance, while the August 1967 photography shows no bank change at this tract, at a location 7,500 ft north of Poison Creek on the same side of the river, a cuspate defined pattern of slumpage is noted. Thus, it is concluded that the factors causing bank changes after 1967 were occurring prior to 1967.

e. Summary. At this tract natural migration of the thalweg and the river reach have been intensified by localized wave activities. These mechanisms were in addition to the factors of mass instability associated with saturation of bank materials, followed by rapid fall in river elevation and erosive mechanisms such as piping and undermining. The activity of all of the various mechanisms associated with removal of bank materials is complex and interrelated.

f. Conclusions. Bank erosion at this site would have occurred by natural phenomena without the construction of the navigation structures and the impoundment of a permanent pool. Of the natural erosion-causing phenomena, bank saturation, drawdown, piping and undermining,

and wave actions are of major significance. The stabilization of stages and flows provided by Corps of Engineers' projects tends to reduce rapid drawdown. However, the interaction of several factors renders it impossible to predict erosion or accretion rates.

g. Refer to Plates 7, 23, 42 and A-16; and Figure B-1-14.

15. Tracts 2410E, 2218E, 2215E(2) Billy C. GLENN ORM 692.5-694.2

a. Hydraulics and Hydrology.

(1) Velocities. The maximum velocity measured on 16 April 1977 at ORM 692.4 was 4.1 ft per sec with a top width of 1,520 ft and a thalweg depth of 58 ft at 5.1 ft above normal pool. The maximum velocity measured on 16 April 1977 at ORM 693.25 was 4.6 ft per sec with a top width of 1,680 ft, a thalweg depth of 55 ft at 4.9 ft above normal pool.

(2) Waves

(a) The effective wind wave fetch region for Tract Nos. 2215E and 2218E is from SSE to NNE with a maximum effective fetch length of 1.4 miles from SSE. The effective wind wave fetch region for Tract No. 2410E is from SSE to NNE direction with a maximum effective fetch length of 0.95 mile from SE.

(b) For Tract 2215E and 2218E the prevailing wind direction within the fetch region is from SSE. For Tract 2410E the prevailing wind direction within the fetch region is SSE.

(c) Tow wave height measurements at ORM 693.25 on 2 May 1977 show maximum wave heights from 0.25 to 1.0 ft. Tow wave height measurements at ORM 692.3 on 3 May 1977 show maximum wave heights from 0.16 to 0.9 ft.

(3) Sailing and Mooring. Federal emergency mooring buoys are located along the opposite bank. There has been no change in sailing lines.

(4) Shoreline Features. A loading dock is located along the bank at ORM 692.5 near the upstream boundary of the property.

(5) River Flows and Stages.

(a) The natural OHW at ORM 694.0 was elev 384.0; the modified OHW was computed to be elev 387.9 for the 383 normal pool and 390.2 for the 386 normal pool.

(b) The 16-ft raising of the normal pool at these tracts from 367.0 to 383.0 has reduced the range of pool fluctuations.

(6) Material Removal. No maintenance dredging has been performed in the vicinity of the site. No specific information is available regarding commercial dredging.

b. Vegetation and Clearing

(1) The vegetation at the upper site is typical of upland areas in well-drained limestone soils (species included tulip poplar, white and chestnut oat, black cherry, hackberry, honey locust, black locust and American elm). The steep slope was quite rocky, allowing sprouting of various herbaceous and woody plants.

(2) The downstream sites (2218 & 2215) includes a wide lower slope devoid of vegetation, near vertical scarps, and an upper bank forested mostly in American elm less than 35 years old. This forest is indicative of a formerly cultivated area. There are several seeps along the scarps. Land behind the elm grove is in corn, which results in enhanced infiltration into the soil.

c. Investigations were conducted at this tract located along the Ohio River and tributary streams on 5 May 1977. Ohio River stage on this date was approximately elevation 384.1 This tract evidenced varied bank conditions including colluvium derived rock debris and terrace sequences of alluvium brown silty clay with trace of fine sand. Seepages were noted in bank areas. Sediment plumes were observed approximate to a tributary and Ohio River confluence near the upstream boundary of the tract. This tract evidences extensive areas of historical landslides with slight erosion occurring within some reaches of lower slopes.

d. Photo Interpretation Notes

(1) Location, Type, Extent. With the aid of a zoom transfer scope and utilizing photographs obtained during 1938, 1961, 1962, 1974 and 1977, bank changes were compared.

(2) Historical changes appear on the right bank of the Ohio River along the southern section of Tract 2410E and Tracts 2215E and 2218E. The Tract 2215E exhibits the greatest amount of change, with a more irregular bank configuration, as compared to Tract 2214E and the southern limits of Tract 2410E. This pattern of bank change in Tract 2215E may be indicative of fine-grained materials. Tract 2218E and the southern section of Tract 2410E exhibit somewhat more uniform slopes, indicative of a coarser grained soil material. The northern section of Tract 2410E where the least change is noted exhibits relatively steep slopes indicative of these potentially less erodible limestone derived colluvial materials.

e. Summary. The primary causes for erosion at these sites are mass instability associated with saturation of bank materials followed by rapid fall in river elevation and piping and undermining. Additionally, the activity of river traffic and particularly the establishment of a loading facility immediately upstream from the tract with attendant fleeting activities appeared to be a factor in the erosion of the bank along this reach of river. Waves generated by this river traffic and by wind appeared to be a possible additional causative factor in bank erosion. The activity of all of the various mechanisms associated with removal of bank materials is complex and interrelated at these tracts.

f. Conclusions. Bank erosion at this site would have occurred by natural phenomena without the construction of the navigation structures and the impoundment of a permanent pool. Of the natural erosion-causing phenomena, saturation of banks and rapid fall in river stage, tow and wind wave action, and maximum tractive forces of flow velocities (as located on the outside of a bend) are of major significance. The stabilization of stages and flows provided by Corps of Engineers' projects tends to reduce rapid drawdown. However, the interaction of several factors renders it impossible to predict erosion or accretion rates.

g. Refer to Plates 7, 22, 43 and A-17 & A-17/1; and Figure B-1-15.

16. Tract 3015E Clyde and Mary BENNER ORM 683.3 to 684.0

a. Hydraulics and Hydrology.

(1) Velocities. No velocity measurements were made near this site.

(2) Waves.

(a) Wind wave fetch region for this property extends from ESE to NW, maximum effective fetch is 0.7 mile from the NW.

(b) Prevailing wind direction within the fetch region is from the NW.

(c) Tow wave height measurements at ORM 684.0 on 2 May 1977 show maximum wave heights ranging from 0.25 to 0.55 ft.

(3) Sailing and Mooring. No change in sailing line and no mooring facilities occur within the site vicinity.

(4) Shoreline Features. No facilities are located in the vicinity of the site.

(5) River Flows and Stages.

(a) The natural OHW at ORM 683.7 was elev 386.7; the modified OHW was computed to be elev 390.0 for the 383 normal pool and 391.9 for the 386 normal pool.

(b) The 16-ft raising of the normal pool from 364 to 383 has reduced the range of pool fluctuations.

(6) Material Removal.

(a) No maintenance dredging was performed in the vicinity of the site.

(b) No specific information was available for commercial dredging.

b. Vegetation and Clearing.

(1) The narrow lower bank is a remnant of a formerly cultivated terrace which had been allowed to revegetate. A fringe of silver maple occurs along the top bank in the upstream portions. These are dense, clumped, and multi-trunked, about 35-40 years old, and indicate a frequently flooded area containing second growth. In the lower part of the site a field was plowed to approximately the top of bank.

(2) Clearing by the Corps removed much of the vegetation from the terrace at the lower part of the property.

c. Soils and Geology. Investigations were conducted at this tract located along the Ohio River and tributary streams on 3 May 1977. Ohio River stage this date was approximately 384.6. This tract evidenced variable topographic, soils and rock outcrop conditions. In the central reach of the tract, recent bank slumpage scarps exposed alluvium consisting of damp layered brown fine sandy silt, clayey silt and silty clay. Benching occurred in lower bank slumpage debris. A terrace was encountered between the upper and lower banks. The upper bank also evidences seepage areas. The upstream reach of the tract consists largely of colluvium with indications of bedrock control at shallow depth. The downstream reach is composed of a single steep bank of alluvial soil. Large drift accumulations were noted.

d. Photo Interpretation Notes.

(1) From available aerial photographs of this site for the period between 1930 and May 1977, a comparative study of bank changes was conducted.

(2) In the 1930 aerial coverage, the terrace and sloping flood plain were being cultivated. Only brush and small tree growth were observed at the boundary between the toe of slope, bank and terrace. The boundaries between the bank and terrace were discerned from the photos by changes in elevation and vegetation.

(3) Little change in bank configuration could be perceived in the 1937 and 1938 aerial coverage. However, trees grown since 1930 located at the edge of the flood plain seem to have been damaged after the 1937 flood. Silt and sand deposited along the bank after the flood changed its configuration slightly.

(4) By 1951, changes in bank had progressed, especially at the drainage exits in the middle area and at the downstream limit of the site.

(5) In the 1967 coverage it was difficult to discern bank changes because of the tree canopy. However, immediately upstream and downstream of a large gully at the downstream limit of the site, changes were perceived.

(6) The April 1971 coverage indicates that changes had occurred since 1930. The difference between the 1930 and 1971 bank indicates bank changes had occurred in the middle area of the site. At both the upstream and downstream ends of the site, the bank had also changed slightly during the same time period.

(7) The February 1977 coverage indicates no perceived change had occurred recently within the middle of the site. This may be a result of rock controls of these banks since outcrops are noted just above this area. At the upstream and downstream area of the tract the bank has continued to change slightly.

e. <u>Summary</u>. Relatively minor erosional activity was observed within the downstream two-thirds of the site. This was considered to be representative of a natural progression of the river within its valley. It was considered that migration of the thalweg and erosional removal by current velocities and shear forces were the predominant mechanisms. The shifting of the thalweg was considered to result from control of river migrations by bedrock at and in the immediate vicinity of the site. Within the upstream one-third of the site the slopes evidenced sliding in colluvial materials.

f. <u>Conclusions</u>. Bank erosion at this site would have occurred by natural phenomena without the construction of the navigation structures and the impoundment of a permanent pool. Of the natural erosion-causing phenomena, shear forces from current velocities as deflected by rock outcrops and colluvium derived rock debris, and sliding of slope colluvium are of major significance. The stabilization of stages and flows provided by Corps of Engineers' projects tends to reduce rapid drawdown. However, the interaction of several factors renders it impossible to predict erosion or accretion rates.

g. Refer to Plates 7, 21, 44 and A-18; and Figure B-1-16.

17. Tracts 3229E and 3238E Nicholas PURCELL

a. Hydraulics and Hydrology.

(1) Velocities. No data were collected at the site.

(2) Waves. No wave data were collected at this site.

(3) Sailing and Mooring. Not applicable at this site.

(4) Shoreline Features. None are located in the vicinity of this site.

(5) River Flows and Stages.

(a) The natural OHW at ORM 678.5 was elev 388.4; the modified OHW was computed to be elev 391.2 for the 383 normal pool and 392.9 for the 386 normal pool.

(b) The 16-ft raising of the normal pool at these tracts from 367 to 383 has reduced the range of pool fluctuations.

(6) Material Removal. Not applicable at this site.

b. Vegetation and Clearing.

(1) Land at the ridge includes a lawn and roadway. The slope to the stream indicates slumping with trees toppled in various directions. Large trees include sycamore, cottonwood, and silver maple.

(2) No clearing was performed by the Corps at this site.

c. Soils and Geology. Field investigations were conducted on 4 May 1977 at this tract located approximate to Mill Creek of the Little Blue River with Ohio River stage at elev. 384.9. Slopes above Mill Creek evidenced historical and recent failure conditions with tension cracks, scarps and stream-cut toe of slide debris being noted. Failure surfaces were within the wet colluvium and approximate to top of rock surfaces. This colluvial slide debris includes materials derived from weathered lacustrine deposits and shaley silty claystone. These materials were classified as brown to gray silty clay to clay and fine sand with iron staining, damp to wet.

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d. Photo Interpretation Notes.

(1) Location, Type, and Extent. The failing slope is located on the right bank of Mill Creek about 3,600 ft upstream of its junction with the Little Blue River. This failure area begins just upstream of the county road bridge located about 1/2 mile north of Alton and extends some 600 ft above the bridge. Examination of photos from 1930 to 1977 resulted in identifying several areas of unstable soils or soil and rock mixtures. On the slopes, slides of colluvium or colluvial mixtures of sandstone, limestone and shale were noted. Glacial lake bed remnants within tributary stream valley areas, such as the Blue, Little Blue, and Mill Creek are related to slides located within and at faces of the dissected remnants.

(2) There are indications that slope changes predate the earliest photography. Further, there are indications that sliding has been active since 1930 within these terrace areas. The most active and severe recent sliding has occurred in the upstream portion of this site. Photos were compared for the years 1936, 1967, 1974, 1976 and 1977 to determine the nature and extent of the toe of slide changes. A readily discernible change was noted utilizing 1967 photos and the 1977 photos. This slope change occurred over a 350-ft section nearest the house. The other photos were examined in an attempt to define the period during which most of the changes occurred. The 1974 photo indicates that approximately half the sliding occurred between 1967-1974 and the remainder between 1974-1977. The other changes were so slight they could not be discerned from photos and the period of occurrence could not be determined. The upper slope appears to be sliding in mass. The mass has moved down the slope taking trees and other vegetative cover along with it. The upper bank is almost devoid of vegetation. Areas of slope failure are indicated by large leaning trees. This indicates a slope which now has no stratified soil structure, but rather is cracked and broken in random directions.

(3) Significant Factors. The lacustrine clays and silts comprising the lower slopes are poorly drained materials. The slopes are subject to saturation by ground water. The sliding mass has numerous cracks and weathered slip surfaces. As the landslides continue to move the soil, trees, brush, and other debris further down the slope, the channel of Mill Creek is restricted and has a lower discharge capacity,. With the stream obstructed, flow is diverted. The trees and other debris within the channel also result in increased turbulence.

(4) Rate of Change. The rate of change at this site probably has little importance since indications are, from the nature of the slope change, that significant failure movements have occurred during several periods rather than continuously.

e. Summary. Saturation of hillside materials is considered to be the significant instability factor. Historic evidence of instability in the immediate vicinity of the tract was established by photo interpretation. Sufficient field observations were conducted to define natural mass movements unrelated to changes in pool elevation.

f. Conclusions. Ground water saturation of hillside materials and mass movement of slope colluvium unrelated to project-modified riverine conditions are of major significance.

g. Refer to Plates 7, 45, and A-19; and Figure B-1-17.

18. Tract 3703E   Ralph COX   ORM 669.8 to 670.2

a. Hydraulics and Hydrology.

(1) Velocities. The maximum velocity measured at ORM 669.0 on 14 April 1977 was 5.7 ft per sec with a top width of 1,400 ft and a thalweg depth of 63 ft, stage 11.0 ft above normal pool.

(2) Waves.

(a) Wind wave fetch region for this property extends from E to NW, maximum effective fetch length is 0.7 mile from the NW.

(b) Prevailing wind direction within the fetch region is from the NW.

(c) Tow wave height measurements at ORM 669.0 on 4 May 1977 show maximum wave heights ranging from 0.55 to 1.4 ft.

(3) Sailing and Mooring. There is no change in sailing line; however, there is a possibility of navigating slightly closer to the bank at slack water since the impoundment of the new pool.

(4) Shoreline Features. A boat launching ramp is located on the bank at mile 669.8

(5) River Flows and Stages.

(a) The natural OHW at ORM 670.0 was elev. 391.0; the modified OHW was computed to be elev 393.3 for the 383 normal pool and 394.8 for the 386 normal pool.

(b) The 16-ft raising of the normal pool from 367 to 383 has reduced the range of pool fluctuations.

(6) Material Removal.

(a) No maintenance dredging was performed at this site.

(b) No specific information on commercial dredging is available for this site.

b. Vegetation and Clearing.

(1) The site has a high bank with a narrow beach. Top of the high bank was plowed within 2 ft of the edge. Shrub growth occurred on the bank, mostly locust. Vegetation establishment was noted near the upstream end of the site, with silver maple and sycamore near the water and hackberry and buckeye located higher on the slopes. These indicate well-drained soils. The largest sycamore and hackberry were aged at less than 35 years.

(2) Erosion-related toppling of trees occurs at this site. Measurements indicate flows near the shore approach shear velocity frequently. Such velocities could contribute to the extent of observed erosion.

(3) Clearing was accomplished by the Corps at this site. Although not extensive, this exposure of cleared bank to shearing velocities probably has contributed to the observed tree toppling.

c. Soils and Geology. Investigations were conducted at this tract on the Ohio River and tributary stream on 4 May 1977. Ohio River stage this date was approximately elevation 383.5. Recent slumpage had exposed scarps within the upper bank and benching had occurred in failure debris. Recent sediment deposition was noted in lower bank areas. Excavations and augering encountered alluvial moist to damp dark brown to brown silty clay with fine sand. Erosional downcutting by a tributary stream was noted.

d. Photo Interpretation Notes.

(1) Location, Type, Extent. Historical bank changes are evident along the entire reach of tract. The upper bank is generally more constant.

(2) Significant Factors. Factors which could have affected bank changes at this site are: the easily erodible silt and silty clay alluvium, the topography of the upper bank (perhaps affected by the existence of a continuous stand of trees during the period of photo coverage), and the effects of tows operating close to the bank.

e. Summary. A natural erosional condition exists which can be attributed to the existence of bedrock and colluvium across the river

and the resulting migration of the eroding river into this reach of bank. More significant causes of erosion at this site are mass instability associated with saturation of bank materials followed by rapid fall in river elevation and piping and undermining. The activity of various mechanisms associated with removal of bank materials is complex and interrelated at this site.

f. Conclusions. Bank erosion at this site would have occurred by natural phenomena without the construction of the navigation structures and the impoundment of a permanent pool. Of the natural erosion-causing and related phenomena, shear forces from current velocities as deflected by rock outcrops and colluvium-derived rock debris, and saturation of bank materials and rapid fall in river stage, and piping of materials and resultant undermining are of major significance. The stabilization of stages and flows provided by Corps of Engineers' projects tend to reduce rapid drawdown. However, the interaction of several factors renders it impossible to predict erosion or accretion rates.

g. Refer to Plates 7, 20, 46 and A-20; and Figure B-1-18.

19. Tract 3828E John H. McGEHEE ORM 668.3 to 668.6

a. Hydraulics and Hydrology.

(1) Velocities. The maximum velocity measured at ORM 669.0 on 14 April 1977 was 5.7 ft per sec with a top width of 1,400 ft and a thalweg depth of 63 ft at 11.0 ft above normal pool or stage 0.7 ft above ordinary high water.

(2) Waves.

(a) Wind wave fetch region for this property extends from ESE to WSW; maximum effective fetch length is 0.72 mile from the SE.

(b) Prevailing wind direction within the fetch region at this site is from the SW.

(c) Tow wave height measurements at ORM 669.0 on 4 May 1977 show maximum wave heights ranging from 0.65 to 1.4 ft.

(3) Sailing and Mooring. There is no change in sailing line; however, submergence of a bar permits navigation closer to the bank under slack water conditions.

(4) Shoreline Features. A boat launching ramp is located on the bank opposite to the property at ORM 669.8.

(5) River Flows and Stages.

(a) The natural OHW at ORM 668.5 was elev 391.4; the modified OHW was computed to be elev 393.7 for the 383 normal pool and 395.2 for the 386 normal pool.

(b) The 16-ft raising of the normal pool from 367 to 383 has reduced the range of pool fluctuations.

(6) Material Removal.

(a) No maintenance dredging was performed in the vicinity of this site.

(b) No specific information is available on commercial dredging.

b. Vegetation and Clearing. There is a stand of young sandbar willow protecting the lower bank and extending up to the high bank. Dense vegetation is present. Little or no active erosion is evident at pool elevations. The upper bank includes a forest of mature black locust, honey locust, and including hackberry, black cherry, mulberry, and elm. There is no vegetation-related evidence of recent major disturbance.

c. Soils and Geology. This tract was investigated on 29 April 1977 with the Ohio River stage at approximately elevation 385.6 Sloping banks along the Ohio River evidenced recent sediment deposition with some slumping and benching of these layered moist brown silty fine sand with trace of clay and leaf fragment deposits. Upper bank alluvium consists of brown silty clay with some fine sand, fine sandy silt with clay, and silty fine sand with trace of clay and organics.

d. Photo Interpretation Notes.

(1) At Tract No. 3828E slight changes along a low natural levee were perceived.

(2) The areas affected by changes are a terrace and a farm road in the early photography, and a low natural levee which was mapped as the top of bank. The terraces appear unchanged. These terraces slope up to a natural levee which was under cultivation or in pasture land between 1912 and 1938. Between 1938 and 1966 changes were perceived in the levee.

(3) The change in top of bank was perceived using 1:6,000 scale 23 November 1976 aerial photos. The initial bank line conditions were discerned from the 1930 photography. A comparison was made between the 1930 top of bank as seen on the aerial photography and the 1912 Ohio

River Navigation Charts. Change of bank before 1930 is suggested, but an accurate comparison between map and photography was not possible because the position of the top of bank by the 1912 contours is indeterminate.

(4) The relative positions of the 1930, 1938, 1961, 1966, and 1976 top of bank were plotted by use of a zoom transfer scope. There was an insignificant amount of bank change between 1930 and 1938. The 1961 imagery was obtained during high water when the pool elevation was at approximately 400. The top of bank corresponds approximately to the water's edge and shows changes when compared with the 1930 and 1938 imagery.

(5) The 1966 imagery indicates that a continuation of these bank changes took place between 1930 and 1961. The 1976 top of bank corresponds approximately to that discerned from the 1966 photography. It is apparent that most bank changes at this site occurred prior to 1966 and prior to the impoundment of the Cannelton Pool.

(6) The 1971, 1973, and 1974 imagery at scales of 1:40,000 and 1:48,000 was not useable for comparison purposes.

(7) Considering bank conditions between 1930 and 1976, it appears that the bank had changed throughout that period. However, the rate of change was greater prior to 1966 than post 1966. The changes taking place at this site today are a continuation of processes occurring prior to the impoundment of the Cannelton Pool.

e. Summary. Erosional activities are relatively insignificant at this site which is located on the convex side of a river bed. The site evidences relatively minor removal of material during high water stages with subsequent reworking and redeposition as the high waters recede. Observations of recent deposition of materials, together with erosional reworking confirm these sequences of river-related actions.

f. Conclusions. No significant bank erosion was n oted. Accretion of debris and sediments and the reworking of these deposits was observed. However, the interaction of several factors renders it impossible to predict either erosion or accretion rates.

f. Refer to Plates 7, 19, 47 and A-21; and Figure B-1-19.

20. Tract 5018E E. Davis McGEHEE ORM 641.8 - 642.2

a. Hydraulics and Hydrology.

(1) Velocities. The maximum velocity measured at ORM 641.4 on 14 April 1977 was 5.1 ft per sec with a top width of 1,500 ft, a thalweg depth of 59 ft, and stage 17.3 ft above normal pool.

(2) Waves.

(a) Fetch region for wind waves at this property extends for E to NW with a maximum effective fetch length of 0.57 mile from the NW.

(b) For this property, prevailing wind direction within the fetch region is from the NW.

(c) Tow wave height measurements at ORM 641.5 on 4 May 1977 show maximum wave heights ranging from 0.38 to 0.67 ft.

(3) Sailing and Mooring. No change occurred in sailing line.

(4) Shoreline Features. The Olin Corporation loading dock is located at ORM 643.3.

(5) River Flows and Stages.

(a) The natural OHW at ORM 641.5 was elev 398.6; the modified OHW was computed to be elev 400.1 for the 383 normal pool and 401.0 for the 386 normal pool.

(b) The 9-ft raising of the normal pool from 374 to 383 has reduced the range of pool fluctuations.

(6) Material Removal.

(a) Moman's bar (ORM 639.6) was dredged from 1937-1946. Spoil material was placed on the Indiana bank from this dredging activity.

(b) No specific data are available on commercial dredging.

b. Vegetation and Clearing.

(1) Growth varied from exposed benches to a willow stand reaching from the water's edge to an upper terrace. The terrace area has a thicket of young sandbar willow, with occasional cottonwood and sycamore.

(2) The former riparian fringe was thinned by Corps clearing operations.

c. Soils and Geology. Field investigations were conducted at this tract located along the Ohio River and within tributary stream

areas on 27 and 28 April 1977. River stage was approximately elev 387.2. Bank erosion conditions noted during tract reconnaissance included slumpage scarp exposures of layered alluvial moist brown clayey silt with fine sand, silty fine sand with some clay, and silty fine sand with benches within lower bank debris. Terrace and lower bank areas evidence recent deposition of dark brown silty fine sand with clay.

d. Photo Interpretation Notes.

(1) Bank Changes. The changes in the bank within this reach were studied by comparing various photos taken between 1938 and 1977.

(2) Location, Type and Extent. There were no major changes in the bank within this reach of river. Several minor changes occurred between the following photo coverage dates: 1961, 1974, 1976, and 1977. There was no change noted between 1961 and 1974. From 1974 to November 1976, there were three locations where bank changes occurred. The amount of change was scaled and determined to increase in the down-river direction. There was one small area where minor bank changes had occurred between November 1976 and February 1977. The maximum bank change was located about the midpoint of the tract. Ground photos here show that there is a scarp where bank changes were most readily discerned. The photos also showed definite benches within the lower bank.

(3) Significant Factors. The alluvial soils comprising the lower terrace along the river bank in this reach are primarily silts and clays with sand. These fine-grained materials are typically underlain by sands and gravels. The bank in some places is slightly higher in elevation than the adjacent farmland. Periods of heavy rainfall and high runoff may result in steady seepage within lower bank areas. The channel configuration in the area of this tract is a long bend with a relatively high bank along the concave side and a point bar deposit on the convex side of the bend. The point bar consists of more erodible material than the high bank alluvium and colluvium on the opposite side of the channel. Small concave erosion features were noted within the 3,300-ft length of bank between these sites. There are more discernible irregularities within this area than within litigant's tracts as perceived utilizing February 1977 photos. Although the areas of irregularity have become somewhat more extensive over the years, they were perceived on photos as early as 1949, but were not discerned on the 1938 photos. There are indications that there has been some bank change in this general area prior to the raising of the pool by Cannelton Dam in 1971.

(4) Rate of Change. The amount and period of changes were reviewed to determine approximate rates. The bank changes had occurred at different locations for each period where photographic data were considered. It was noted that most of the changes occurred where the banks are 5 to 10 ft lower in elevation than in the adjacent areas.

It is noted that these areas of lower bank elevation are subjected to more frequent flooding. Numerous breaks were common in the bank where slump-related changes were perceived. Slumping changes were perceived in the more recent photographic coverage of 1974-1977.

e. Summary. This tract exhibits mass instability from flow of groundwater with attendant removal of granular materials. This removal may result in the collapse of large blocks along the face of the bank which then interrupt groundwater flow, leading to pressure build-up and further instability.

f. Conclusions. Bank erosion at this site would have occurred by natural phenomena without the construction of the navigation structures and the impoundment of a permanent pool. Of the natural erosion-causing phenomena, groundwater flow, mass instability of bank materials, and piping and resulting undermining are of major significance. The stabilization of stages and flows provided by Corps of Engineers' projects tends to reduce rapid drawdown. However, the interaction of several factors renders it impossible to predict erosion or accretion rates.

g. Refer to Plates 8, 18, 48 and A-22; the Figure B-1-20.

21. Tracts 5101E & 5112E John H. McGEHEE ORM 639.5 - 641.1

a. Hydraulics and Hydrology.

(1) Velocities. The maximum velocity at ORM 641.4 on 14 April 1977 was 5.1 ft per sec with a top width of 1,500 ft, thalweg depth of 59 ft, and stage 17.3 ft above normal pool.

(2) Waves.

(a) Fetch region for wind waves at this property extends from E to NW with a maximum effective fetch length of 0.57 mile from the NW.

(b) For this property, prevailing wind direction within the fetch region is from the NW.

(c) Tow wave height measurements at ORM 641.5 on 4 May 1977 show maximum wave heights from 0.33 to 0.67 ft.

(3) Sailing and Mooring. There is no change in sailing line.

(4) Shoreline Features. The Olin Corporation loading dock is located at ORM 643.3.

(5) River Flows and Stages.

(a) The natural OHW at ORM 641.5 was elev 398.6; the modified OHW was computed to be elev 400.1 for the 383 normal pool and 401.0 for the 386 pool.

(b) The 9-ft raising of the normal pool from 374 to 383 has reduced the range of pool fluctuations.

(6) Material Removal.

(a) Moman's bar (ORM 639.6) was dredged from 1937-1946. The material was placed on the Indiana bank.

(b) No specific data are available on commercial dredging at this site.

b. Vegetation and Clearing.

(1) A good willow growth was established from the water's edge to the upper terrace. Within the terrace area a thicket of dense, young sandbar willow 3-8 years old was encountered. Occasional silver maple and cottonwood were noted within the upper willow thicket. Some root exposure occurs along the water's edge, but no toppling was observed. The lower benches appear to be areas of deposition with willow growth. Erosional conditions may result from shear forces which approach critical velocity at the site at relatively low flood stages.

(2) The former narrow riparian fringe was largely cleared by the Corps. The occasional cottonwood and silver maple noted were isolated and above the clearing line. This fringe was quite narrow with farm operations approximate to the banks.

c. Soils and Geology. Investigations were conducted during 28-29 April 1977 and on 5 May 1977 at these tracts located along the Ohio River and within tributary stream areas. Ohio River stages were approximately 385.6 on 29 April and 385.3 on 5 May. This tract exhibited variable topographic, soils and rock conditions. Transverse cracking was noted 10 ft to 12 ft back of the top of bank. Recent slumpage scarps exposed and excavation and auger sampling encountered alluvial and fluvial glacial intermixed, layered and cross-bedded materials. These materials were classified as layered and lensing moist to damp brown silty clay, clayey silt with fine sand, and sandy silt with clay and as moist brown silty clay with fine sand, silty fine sand, and fine to coarse sand and gravel. Rapidly downcutting tributary streams also exposed these materials and buried wood. Drift accumulations were observed. Seeps and springs were noted within the relatively pervious sands and gravels.

d. Photo Interpretation Notes. The changes in the bank line in this reach were studied by comparing various photos taken between 1938 and 1977.

(1) Location, Type and Extent. There were no major changes in the bank within this reach of river. Several minor changes occurred between the following photos: 1961, 1974, 1976, and 1977. There are three locations where bank change occurred between 1961 and 1974. Between 1974 and 1976 there are six small areas where changes were observed. Most of these changes were within the downstream 400 ft of the tract. Ground photos show that there is typically a very steep slumpage scarp from 2 to 4 ft in vertical extent at some of the locations where bank failure has occurred.

(2) Significant Factors. The soils comprising the lower terrace and upper bank in this reach are alluvial silts and clays with fine sand. These fine-grained materials are typically underlain by sands and gravels. The bank in some places is slightly higher in elevation than the adjacent farmland. Periods of heavy rainfall and high runoff may result in steady seepage within lower bank areas. The channel configuration is a long bar with a relatively high bankline along the concave side and a point bar deposit on the convex side of the bend and within the area of this tract. The point bar side consists of more erodible material than the colluvium banks on the opposite side of the channel. Also noted were small concave erosion features in the 3,300-ft length of bank immediately downstream of this site. There are more discernible irregularities within this area than within these litigant's tracts as perceived utilizing February 1977 photos. Although the area of the irregularities has become somewhat more extensive over the years, they were perceived on photos obtained as early as 1949, but were not discerned on the 1938 photos. There are indications that there has been some change of bank in this general area prior to the raising of the pool by Cannelton Dam in 1971.

(3) Rate of Change. The amount and period of changes was reviewed to approximate rates. The bank changes at both sites have occurred at different locations for each period where photographic data were considered. It was noted that most of the bank change occurred in a general area where the banks are 5 to 10 ft lower in elevation than in the adjacent areas. The only apparent significance to this is that the areas of lower bank elevation are subjected to more frequent flooding. Numerous breaks were common in the bank where slump-related changes were perceived. In the reach downstream of this site, changes in the bank line were discerned from photography obtained.

e. Summary. These tracts exhibit mass instability from flow of groundwater removing granular materials. This removal may result in the collapse of large blocks along the face of the bank which then

interrupt groundwater flow, leading to pressure build-up and further instability. In the upstream reach, gently sloping and stepped banks were noted as resulting from piping failures in the stratified sands, gravels, and silt.

f. Conclusions. Bank erosion at this site would have occurred by natural phenomena without the construction of the navigation structures and the impoundment of a permanent pool. Of the natural erosion-causing phenomena, mass instability of bank materials, groundwater flows, and piping with resulting undermining are of major significance. The stabilization of stages and flows provided by Corps of Engineers' projects tends to reduce rapid drawdown. However, the interaction of several factors renders it impossible to predict erosion or accretion rates.

g. Refer to Plates 8, 18, 49, A-23 and A-23/1; and Figure B-1-21.

22. John DICKENSON ORM 724.6

a. Hydraulics and Hydrology.

(1) Velocities. The maximum velocity measured at ORM 724.4 on 15 April 1977 was 4.4 ft per sec with a top width of 2,180 ft and a thalweg depth of 45 ft at a stage 18.3 ft above normal pool.

(2) Waves.

(a) The effective wind wave fetch region for this site extends from SE to NW, with maximum effective fetch length of 1.14 miles from the NW.

(b) Tow wave height measurements at ORM 724.5 on 30 April 1977 show maximum wave heights ranging from 0.4 to 1.0 ft.

(3) Sailing and Mooring. There are no changes in sailing lines. Federal emergency buoys are located in the vicinity of the site.

(4) Shoreline Features. A loading dock and a recreational boat launching ramp are located on the shore in the vicinity of the site.

(5) River Flows and Stages.

(a) The natural OHW at ORM 724.6 was elev 376.5; the modified OHW was computed to be elev 376.7.

(b) The normal pool was not raised at this tract.

(6) Material Removal. No maintenance dredging has been performed at this site. No specific information is available on commercial dredging.

b. Vegetation and Clearing.

(1) A gravel reach extends 6 to 8 ft from the water line to a steeper bank slope which evidences recent slumping. A thicket of sandbar willow covers the upper bank and much of the slope except along the slumpage scarps. Ground cover varies from none to a thick intertwining of poison ivy and Virginia creeper along the bank, with willows. Mature sycamore and cottonwood occur along the bank, with shrub silver maple and alder.

(2) No clearing was performed by the Corps at this site.

c. Soils and Geology. Field investigations were conducted on 3 May 1977 at this upper Newburgh pool site, with Ohio River stage at elev 365.5 The bank consists of a steep scarp and lower slope reach. Coal and charcoal were encountered at depth within alluvial bank materials. A drain and standing waste water were noted behind the top of bank near an area of maximum erosion. Concrete slabs had been placed in this area. Sampling at scarp and within lower slope areas encountered alluvial moist to wet brown clayey silt with fine sand.

d. Photo Interpretation Notes.

(1) The 1930, 1937, 1961 and 1977 photography was noted as showing a sequence of bank changes.

(2) Comparisons of the 1930 and 1938 photography indicates that bank change may have occurred at one time, possibly during the flood of 1937. The examination of recent photography suggests that bank changes are now being affected by structures in the immediate area (for example a port facility).

e. Summary. Relatively insignificant erosion was noted at this site. Localized saturation of bank materials appeared to be caused by discharge of domestic waste water. Also, generation of waves by river traffic was observed. A localized concentration of river traffic relatively close to the property was noted.

f. Conclusions. Bank erosion at this site would have occurred by natural phenomena without the construction of the navigation structures and the impoundment of a permanent pool. Of the natural erosion-causing phenomena, localized saturation of bank materials and tow-generated wave action are of major significance. The interaction of several factors renders it impossible to predict erosion or accretion rates.

g. Refer to Plates 7, 28, 50 and A-24; and Figure B-1-22.

V. SUMMARY AND CONCLUSIONS

1. General. Summary statements and conclusions for individual sites are included as subparagraphs e. and f. in Section IV. Study-derived summary and conclusions follow.

2. Summary. An analysis has been made of each of the sites in the pools concerning their stability and types of forces to which they are subjected. The sites have been classified into three broad categories: (1) those in which there is accretion or minor erosion, (2) those that are affected primarily by colluvial slides, and (3) those that show some bankline instability that is substantially caused by drawdown-related slumpages, seepage of groundwater, river currents, or waves.

The present Ohio River is geologically stable and has inherited its major patterns and locations from its Pleistocene predecessor. As compared to that predecessor, the reduced discharge, flat gradient, controls, and resistant bank materials preclude major channel change. It is certain that serious bank erosion has occurred during the major floods of the past; however, the damage is repaired naturally. Hence, at any one site the bank position will fluctuate depending on meteorologic and hydrologic conditions. The width of the meander belt is controlled by impingement of the river on rock. However, as with all rivers, the present Ohio, within constraints imposed by its history, is dynamic and conforms to the laws of geomorphology and hydraulics. Therefore, bank erosion and channel changes within the limits of the rock controls do take place.

The forces causing changes in the geometry of the river system include the erosive actions of flows, slope failures, wind and boat waves, ice, and seepage resulting from groundwater flows. In terms of the importance of these forces, an analysis of data and river systems indicates that the major forces affecting channel alignment and bank erosion are the actions of the flowing water, bank slides, and related phenomena. The effects of water seepage are, in general, difficult to assess, but in some cases may be rather significant. Changes in the system created by wind and ice are less important and, in most cases, are insignificant in their effects

The magnitude of wind-generated waves is determined by several factors such as wind speeds, directions and fetch lengths, which are variable from site to site. As noted in Section IV, the maximum fetch lengths vary between 0.7 to 1.4 miles. The range of wind wave heights from these fetches generated by all but the most extreme wind speeds are comparable to those of tow-generated waves given in Section IV. Due to the short fetch lengths, wind waves are relatively small when compared to locations such as ocean shores where unlimited fetch lengths result in substantially higher wind waves and associated forces, which are primary causes of shore erosion.

Considering recent river development, many changes have been effected that in general increased the stability of the river system. Specifically, the reservoirs constructed within the Ohio River drainage basin control approximately 30 percent of the contributing area. These reservoirs reduce peak flows and increase the stability of the system. In addition, the construction of the locks and dams hold river stages at a rather constant level during normal and low flow periods. This stability of water level reduces the amount of rise and fall of the water against the riverbank and consequently reduces changes that would otherwise contribute to the instability of the banks. More specifically, this condition reduces seepage forces and weight forces acting on the bank. Thus, Federal developments both off and on the river have improved control of stages and the system tends to be more stable than it was in its natural state.

A number of possible mechanisms of bank change were identified within the Newburgh, Cannelton and the Meldahl Pools. Predominant among these mechanisms is mass instability, commonly referred to as slumping or sliding. The term "mass instability" is considered to refer to situations in which a combination of increases in forces tending to cause bank failure combined with conditions which reduce the resistance of bank materials result in failure. The greatest increase in forces which tend to cause collapse of the riverbanks is the lowering of the water level next to the bank with related pore pressure increases and subsequent strength reductions. The higher pools associated with the new high-lift structures result in lesser drawdown than with the old slackwater system. This is demonstrated on Fig. V-1. The lesser drawdown increases bank stability.

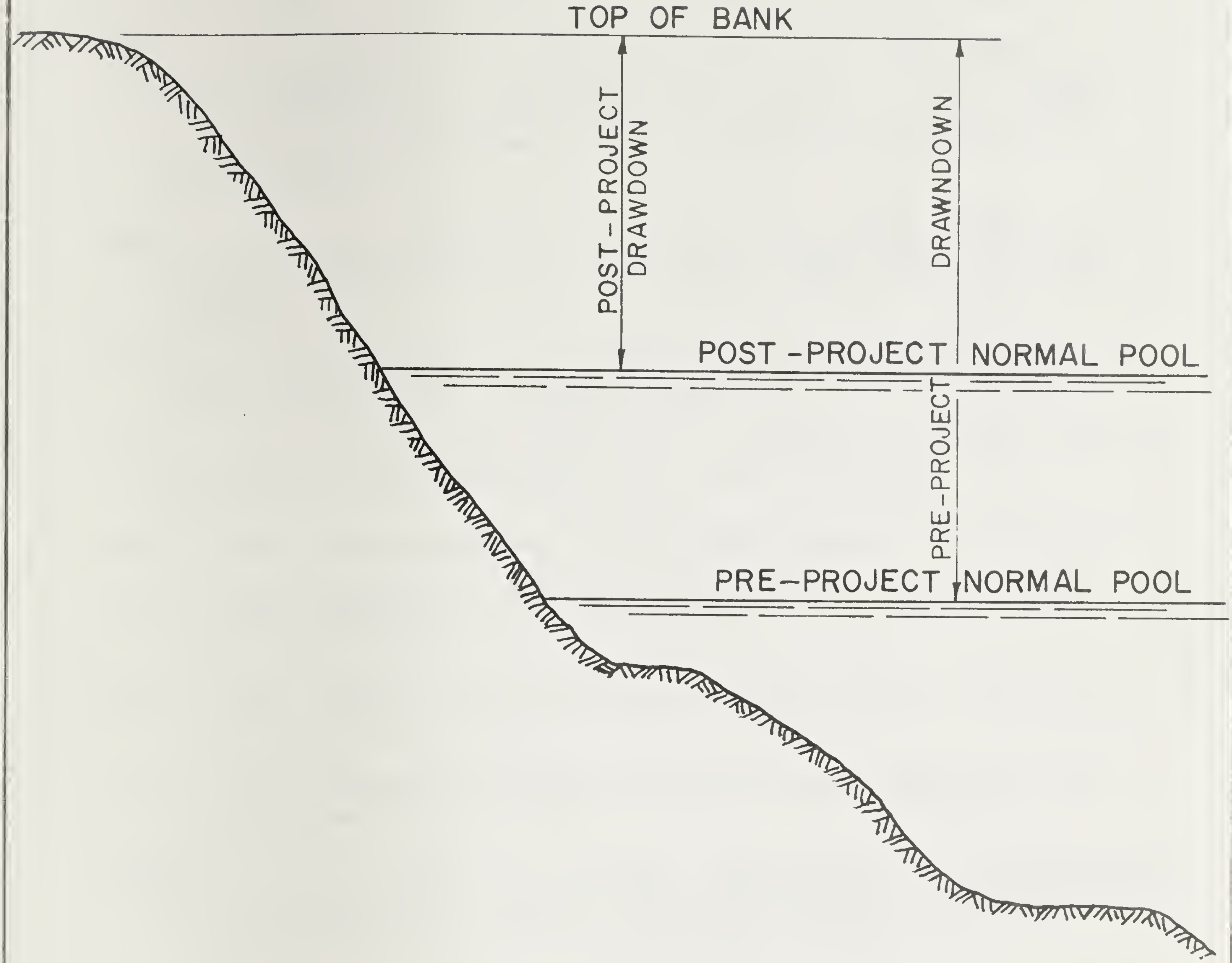
In addition to slumping and removal of bank materials as described above, these materials are removed through the activity of water flowing through soil layers in the riverbank. Characteristically, the alluvial materials in the riverbanks are deposited in thin layers and significant variation in grain size and permeability occurs within these layers. These soil structures result in seepage of water along more permeable layers which generally consist of fine sands or sands and gravels. The passage of water along these layers tends to remove individual particles of these granular materials at the face of the bank, in turn removing support for overlying materials. This type of activity is generally referred to as piping failure and is a rather common phenomenon in stratified alluvial materials. In general, the greatest potential for seepage and piping type failures occur when the greatest gradient exists between the water level within the streambanks as compared to the water level in the adjacent river. Flow systems such as cropland drainage or discharge of wastewaters result in localized bank saturation. Seepage and piping

failures may occur after rapid fall of river stage following periods of high water. In all of these situations, the creation of a high gradient causing flow of water through granular layers leads to the removal of individual grains of the granular layered material and produces instability within the bank materials.

Another causative factor in bank erosion is a grain by grain removal of material by water contact. In some cases this water contact takes the form of a shear stress associated with the current velocities at the contact point between the river waters and the bank. In other instances, grain by grain removal is caused by the impingement of waves on the bank near the water line. These mechanisms may represent a predominant factor for removal of material at a particular site. Additionally, these mechanisms may trigger or initiate mass movements where this removal changes a situation from critical equilibrium to one of immediate failure. A mass of bank material may be in an incipient failure condition and a localized slight removal of material through water contact may initiate a mass failure of much greater magnitude than the removal associated with the wave activity only.

Mass movements of bank materials may significantly change the erosion potential. For example, large blocks of material may fall from their original positions and lodge at a lower elevation. At this level they could block the flow of ground water through more pervious materials and consequently change the overall stability of the bank by inducing water pressure and thereby reducing the shear strength of the material. In other cases, the slumping of a large mass of material to a lower elevation may temporarily protect the bank at that elevation from the erosive action of waves. Local reworking of slump debris by wave action and current velocity has been noted at a number of sites.

3. Conclusions. Bank erosion would have occurred along the Ohio River, including the tracts under litigation, by natural phenomena without the construction of navigation structures and the impoundment of permanent pools. Of these phenomena the most significant erosion causative factors are failure of banks during and following wet periods and the reworking and transport of slumpage debris. Significant erosion conditions and bank failures following floods have been noted in historic records. Ohio River navigation structures have been constructed throughout the past 50 years and conditions of moderate to severe erosion have been noted within all reaches regardless of the periods of impoundment.



SCHEMATIC DIAGRAM OF DRAWDOWN

FIGURE V-1

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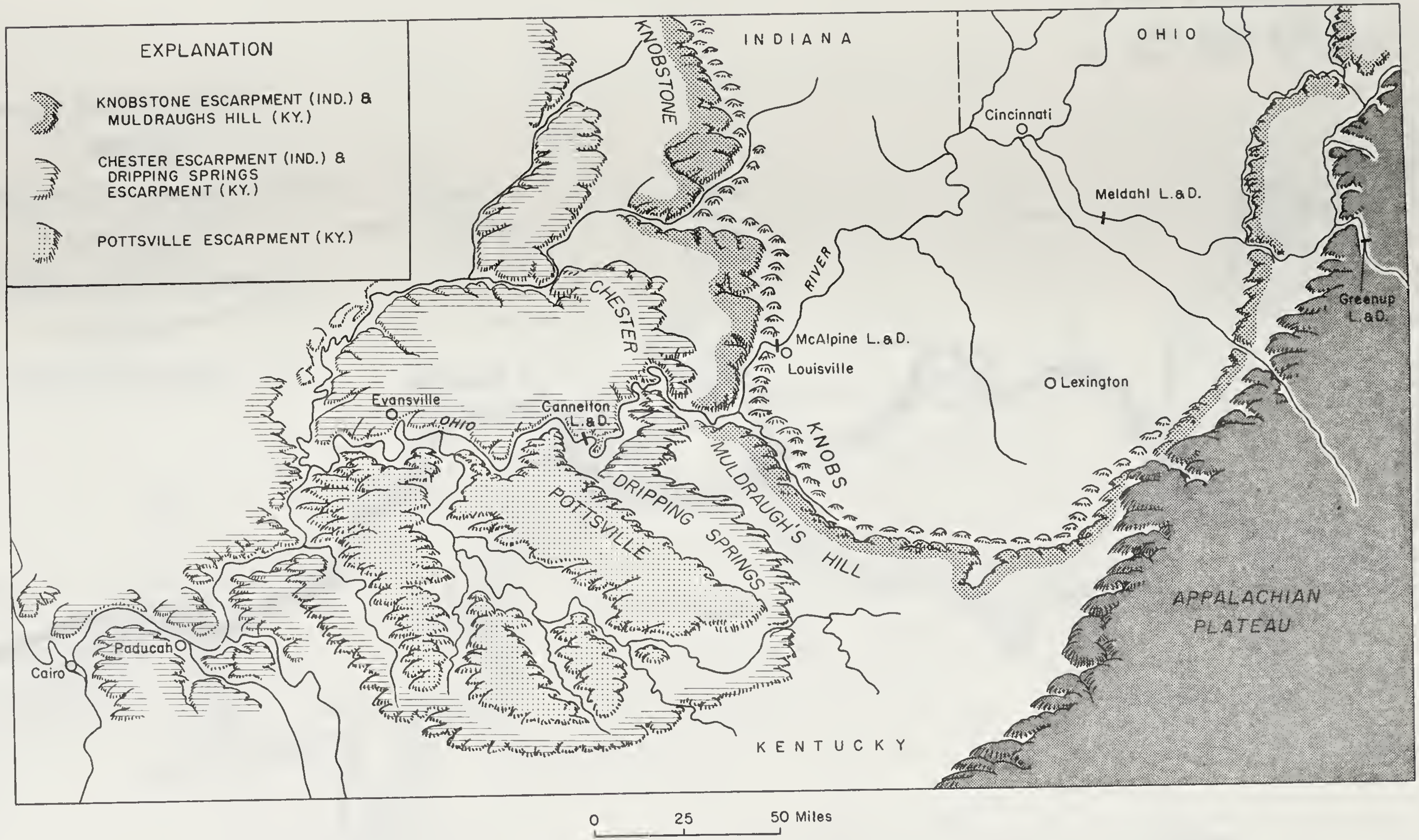


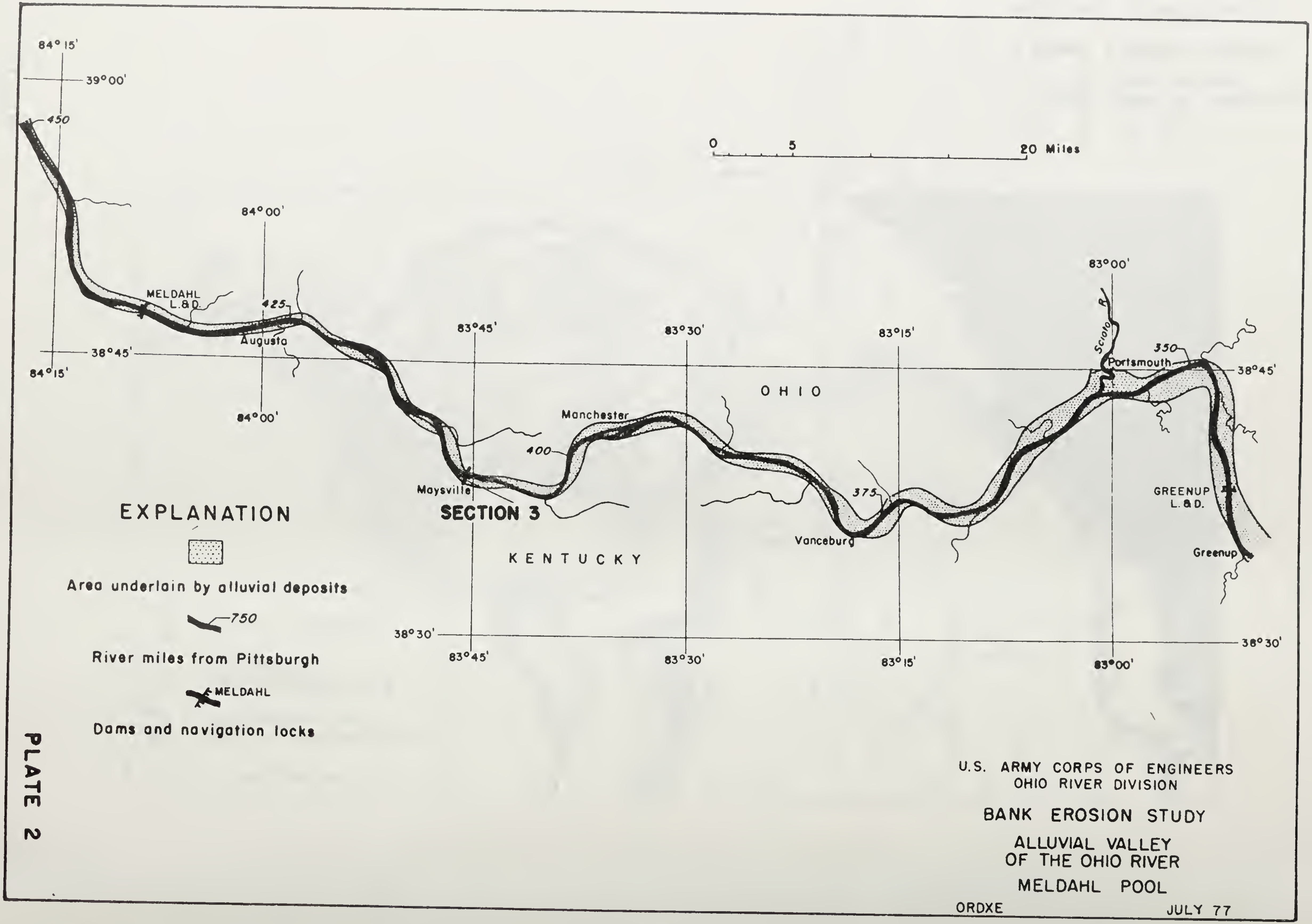
U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION

BANK EROSION STUDY

REGIONAL GEOMORPHOLOGY

ORDXE JULY 77

PLATE I



U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION

BANK EROSION STUDY

ALLUVIAL VALLEY
OF THE OHIO RIVER

MELDAHL POOL

ORDXE JULY 77

PLATE 2

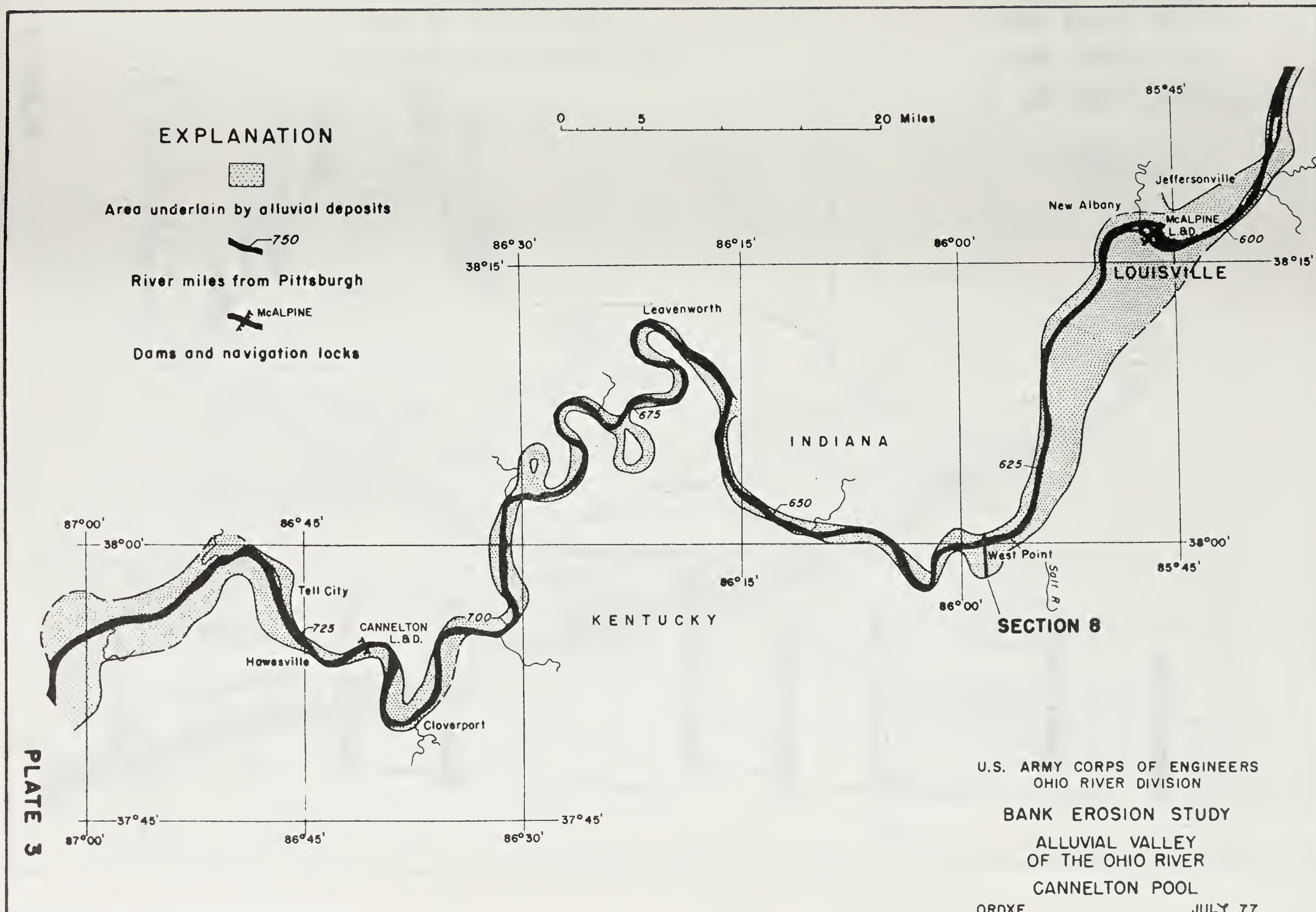
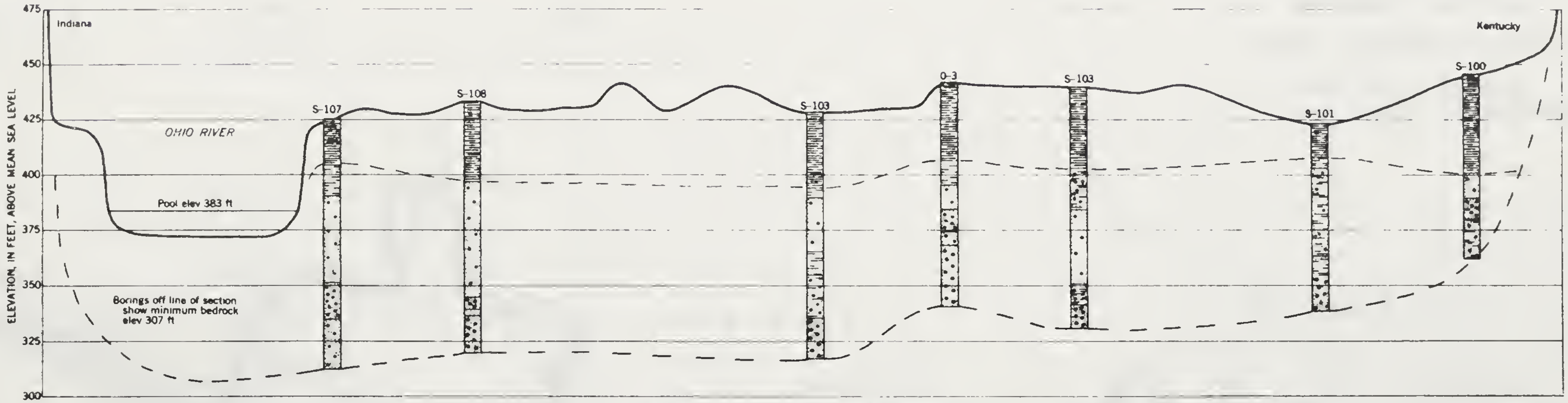

EXPLANATION
Area underlain by alluvial deposits
750
River miles from Pittsburgh
McALPINE
Dams and navigation locks
0
5
20 Miles
85°45'
Jeffersonville
New Albany
McALPINE L.&D.
600
LOUISVILLE
38°15'
86°30'
86°15'
86°00'
Leavenworth
675
INDIANA
625
650
87°00'
86°45'
38°00'
Tell City
725
CANNELTON L.&D.
Howesville
700
KENTUCKY
West Point
Salt R.
SECTION 8
Cloverport
37°45'
U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY
ALLUVIAL VALLEY
OF THE OHIO RIVER
CANNELTON POOL
ORDXE
JULY 77

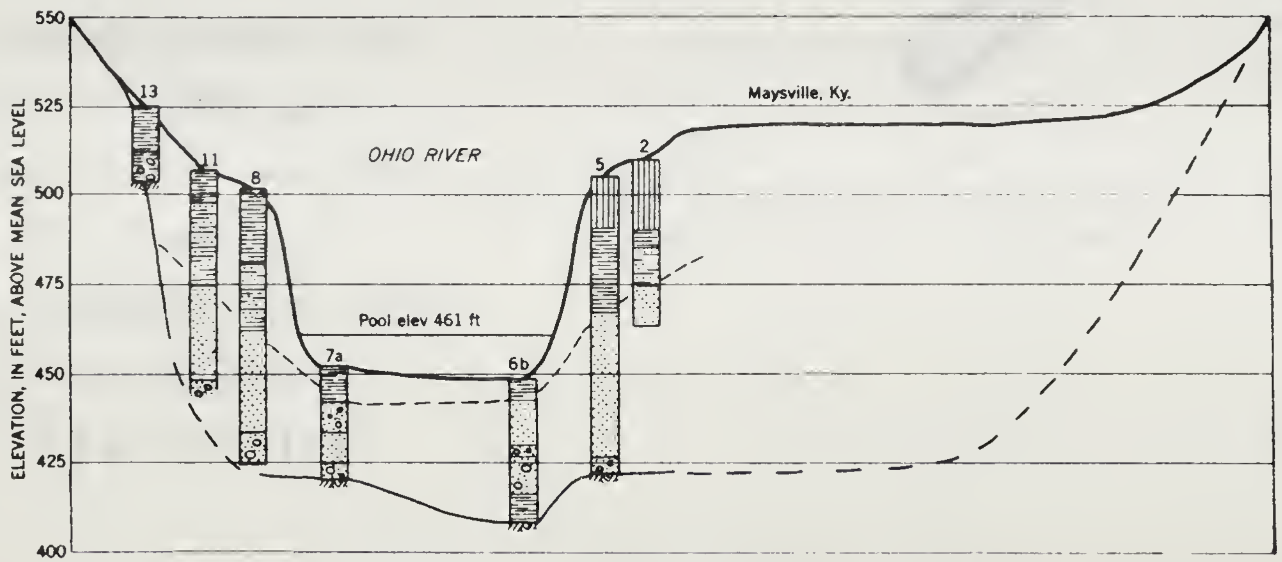
PLATE 3



BORINGS AT FORT KNOX, KY., WELL FIELD, RIVER MILE 631

500 0 1500 Feet

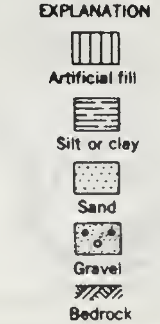
SECTION 8



BORINGS FOR ABERDEEN-MAYSVILLE HIGHWAY BRIDGE AT RIVER MILE 408.4

500 0 1500 Feet

SECTION 3



Numbers above borings are those given on original bridge plans, except as otherwise noted

U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION

BANK EROSION STUDY

OHIO RIVER VALLEY CROSS SECTIONS

ORDXE JULY 77

PLATE 4

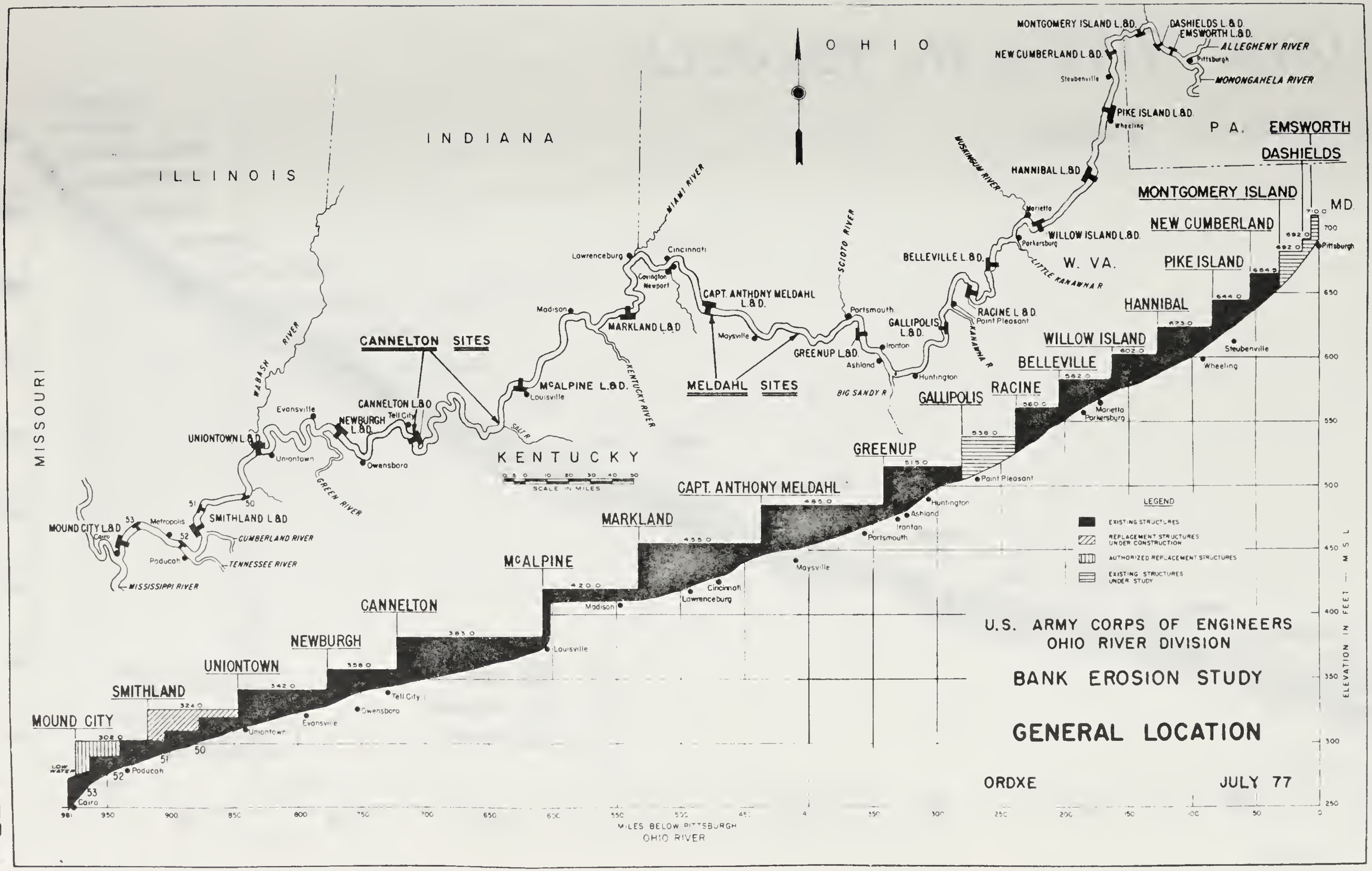
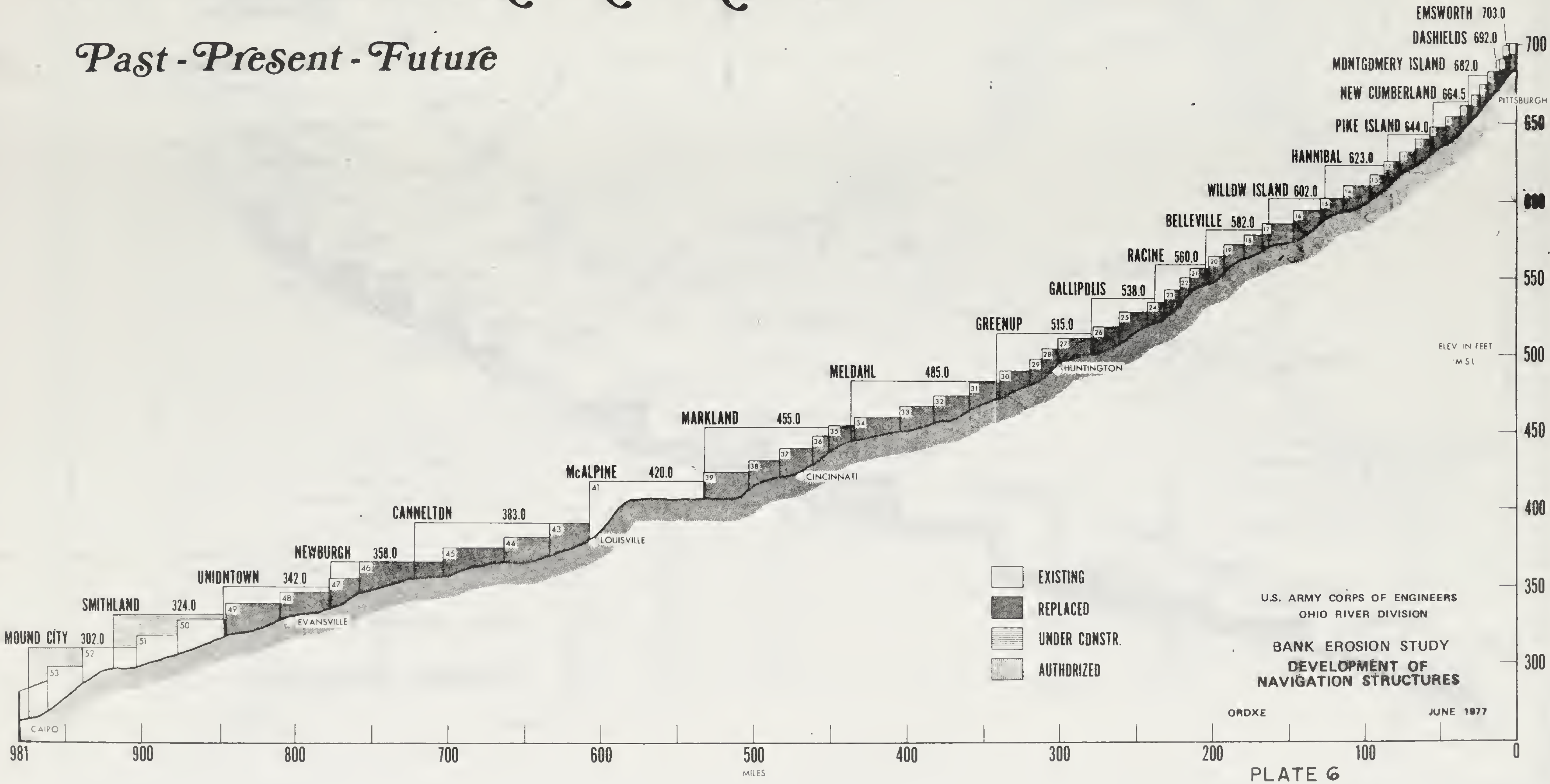

U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY
GENERAL LOCATION
ORDXE
JULY 77
LEGEND
EXISTING STRUCTURES
REPLACEMENT STRUCTURES UNDER CONSTRUCTION
AUTHORIZED REPLACEMENT STRUCTURES
EXISTING STRUCTURES UNDER STUDY
ILLINOIS
INDIANA
OHIO
KENTUCKY
MISSOURI
W. VA.
P A.
MD.
CANNELTON SITES
MELDAHL SITES
MONTGOMERY ISLAND L.&D.
DASHIELDS L.&D.
EMSWORTH L.&D.
ALLEGHENY RIVER
MONONGAHELA RIVER
NEW CUMBERLAND L.&D.
PIKE ISLAND L.&D.
HANNIBAL L.&D.
WILLOW ISLAND L.&D.
BELLEVILLE L.&D.
RACINE L.&D.
GALLIPOLIS L.&D.
GREENUP L.&D.
CAPT. ANTHONY MELDAHL L.&D.
MARKLAND L.&D.
McALPINE L.&D.
CANNELTON L.&D.
NEWBURGH L.&D.
UNIONTOWN L.&D.
SMITHLAND L.&D.
MOUND CITY L.&D.
MUSKINGUM RIVER
LITTLE KANAWHA R
KANAWHA R
BIG SANDY R
SCIOTO RIVER
MIAMI RIVER
KENTUCKY RIVER
SALT R
GREEN RIVER
WABASH RIVER
CUMBERLAND RIVER
TENNESSEE RIVER
MISSISSIPPI RIVER
SCALE IN MILES
EMSWORTH
DASHIELDS
MONTGOMERY ISLAND
NEW CUMBERLAND
PIKE ISLAND
HANNIBAL
WILLOW ISLAND
BELLEVILLE
RACINE
GALLIPOLIS
GREENUP
CAPT. ANTHONY MELDAHL
MARKLAND
McALPINE
CANNELTON
NEWBURGH
UNIONTOWN
SMITHLAND
MOUND CITY
ELEVATION IN FEET — M S L
MILES BELOW PITTSBURGH
OHIO RIVER

PLATE 5

THE OHIO RIVER IN PROFILE

Past - Present - Future



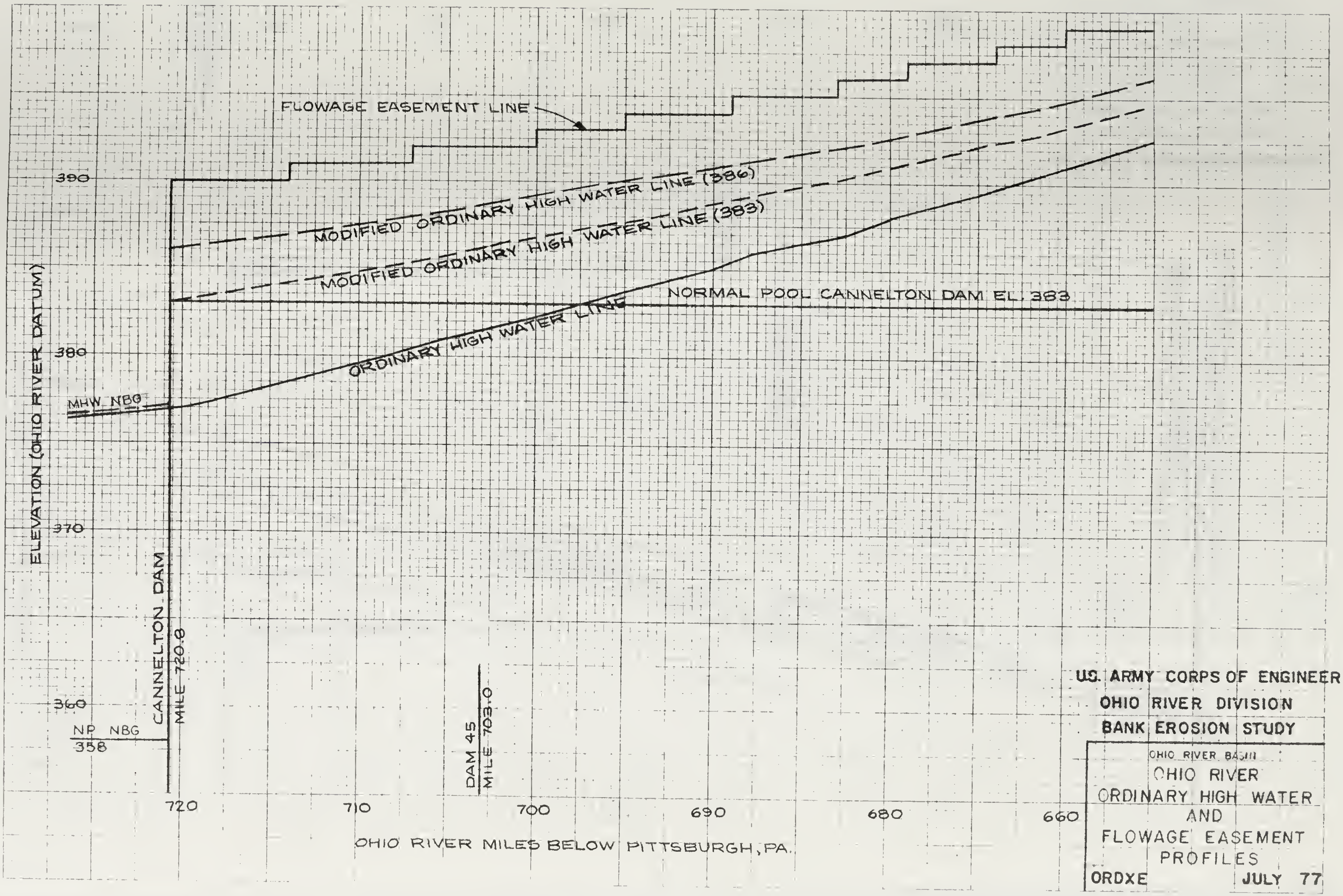
U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION

BANK EROSION STUDY
DEVELOPMENT OF
NAVIGATION STRUCTURES

ORDXE

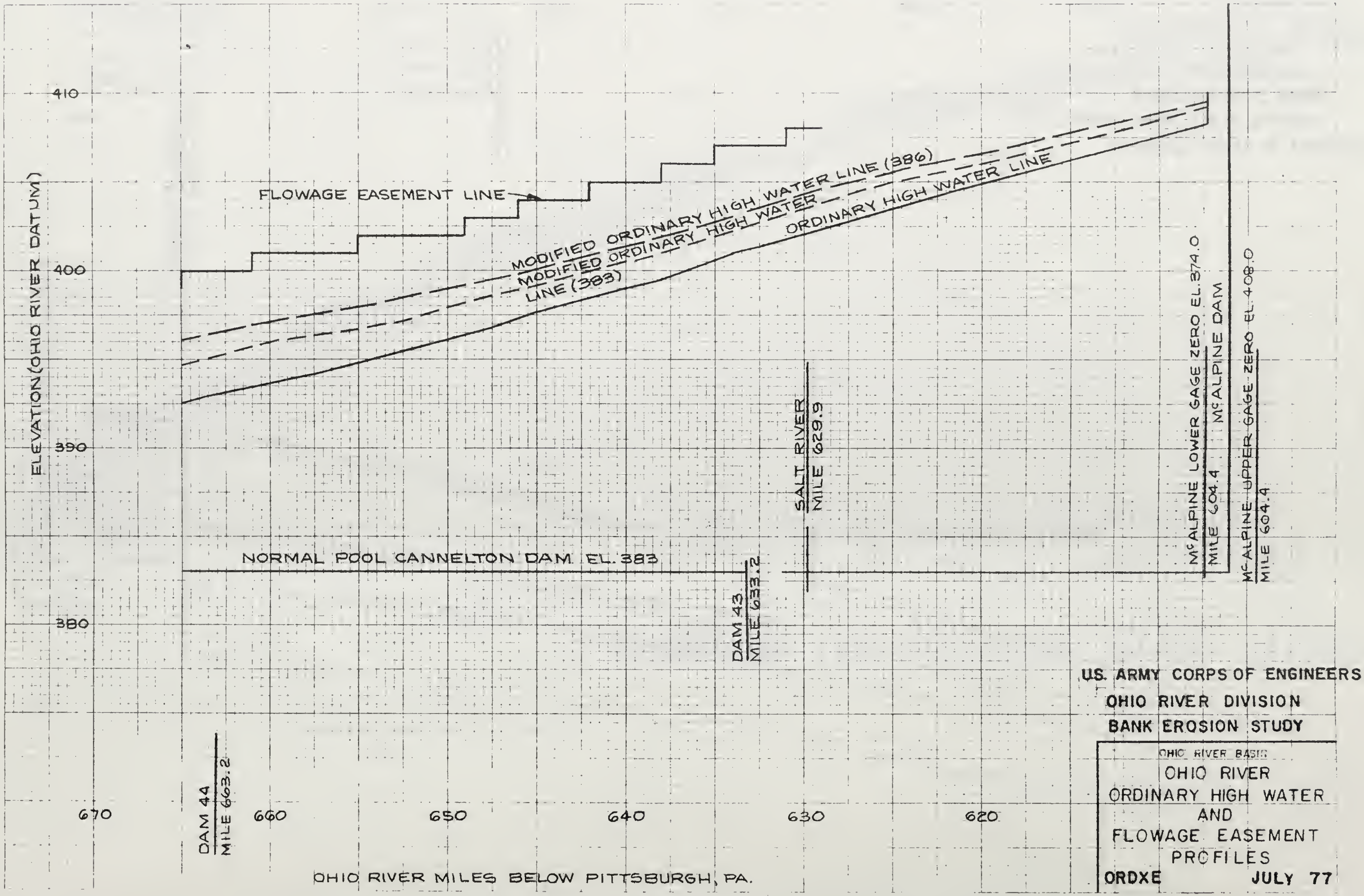
JUNE 1977

PLATE 6



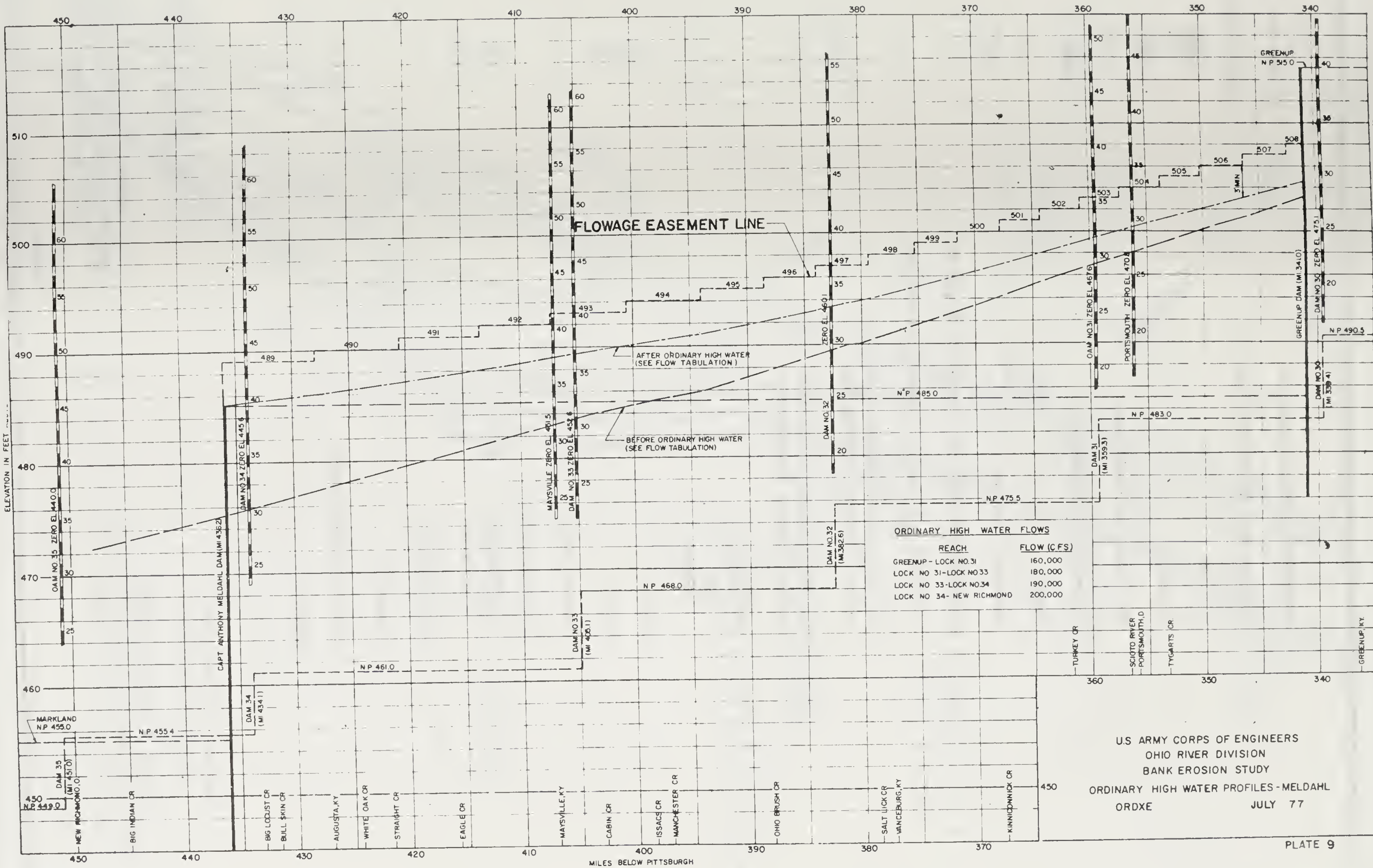
FLOWAGE EASEMENT LINE
MODIFIED ORDINARY HIGH WATER LINE (386)
MODIFIED ORDINARY HIGH WATER LINE (383)
NORMAL POOL CANNELTON DAM EL. 383
ORDINARY HIGH WATER LINE
MHW NBG
NP NBG
358
CANNELTON DAM
MILE 720.8
DAM 45
MILE 703.0
ELEVATION (OHIO RIVER DATUM)
390
380
370
360
720
710
700
690
680
660
OHIO RIVER MILES BELOW PITTSBURGH, PA.
U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY
OHIO RIVER BASIN
OHIO RIVER
ORDINARY HIGH WATER
AND
FLOWAGE EASEMENT
PROFILES
ORDXE
JULY 77

PLATE 7



ELEVATION (OHIO RIVER DATUM)
410
400
390
380
FLOWAGE EASEMENT LINE
MODIFIED ORDINARY HIGH WATER LINE (386)
MODIFIED ORDINARY HIGH WATER LINE (383)
ORDINARY HIGH WATER LINE
NORMAL POOL CANNELTON DAM EL. 383
DAM 44
MILE 663.2
DAM 43
MILE 633.2
SALT RIVER
MILE 629.9
McALPINE LOWER GAGE ZERO EL. 374.0
MILE 604.4
McALPINE DAM
McALPINE UPPER GAGE ZERO EL. 408.0
MILE 604.4
670
660
650
640
630
620
OHIO RIVER MILES BELOW PITTSBURGH, PA.
US. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY
OHIO RIVER BASIN
OHIO RIVER
ORDINARY HIGH WATER
AND
FLOWAGE EASEMENT
PROFILES
ORDXE
JULY 77

PLATE 8



REACH	FLOW (C.F.S.)
GREENUP - LOCK NO.31	160,000
LOCK NO 31 - LOCK NO 33	180,000
LOCK NO 33 - LOCK NO 34	190,000
LOCK NO 34 - NEW RICHMOND	200,000

U.S ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY
ORDINARY HIGH WATER PROFILES - MELDAHL
ORDXE JULY 77

PLATE 9

LEGEND

Pre-Cannelton or **Meldahl channel line**	
Post-Cannelton or **Meldahl channel line**	
U.S. Light	
Daymark	
Pre-Cannelton and Meldahl buoys:	
Post-Cannelton and Meldahl buoys:	
Gage	
Arrival point for lockage	AP
Waters edge at pool stage before **Cannelton** or **Meldahl** Pools	
Waters edge at pool stage after **Cannelton** or **Meldahl** Pools	
Bar, with less than project 9-foot depth at pool stage before **Cannelton** or **Meldahl Pools**	
Bar, with less than project 9-foot depth at pool stage after Cannelton or **Meldahl Pools**	
Aerial crossings:	
Power	
Telephone	
Dock	
Intake	
Submarine crossing	
Recreational Facilities	
Launching Ramp	R
Dock Marina	
Mooring Facilities	
Fleeting Area	x
Ordinary High Water Elevation	*OHW 000*
Reach limits	

U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION

BANK EROSION STUDY
MODIFICATION OF SAILING LINE
AND NAVIGABLE DEPTH

ORDXE

JULY 1977

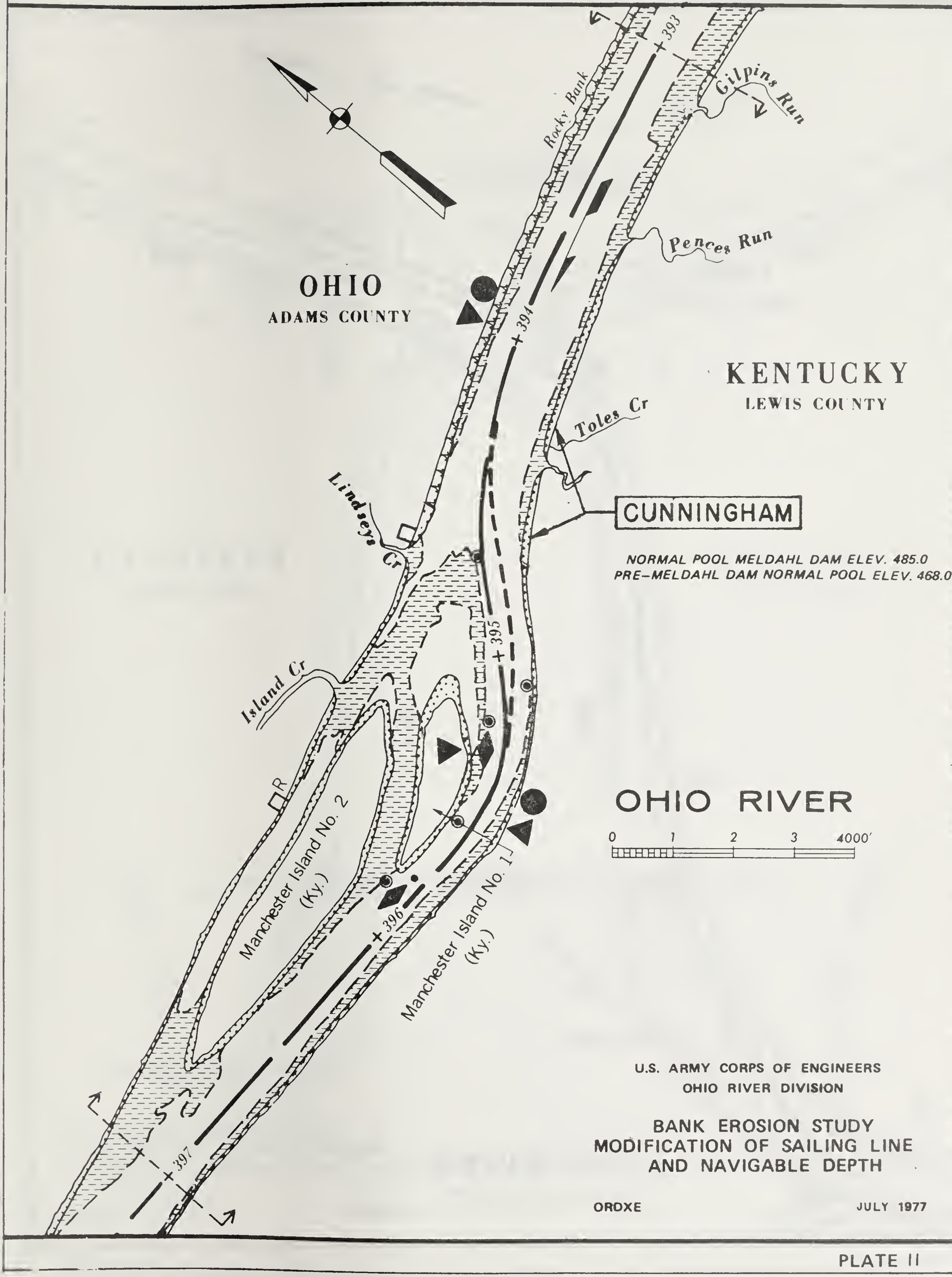
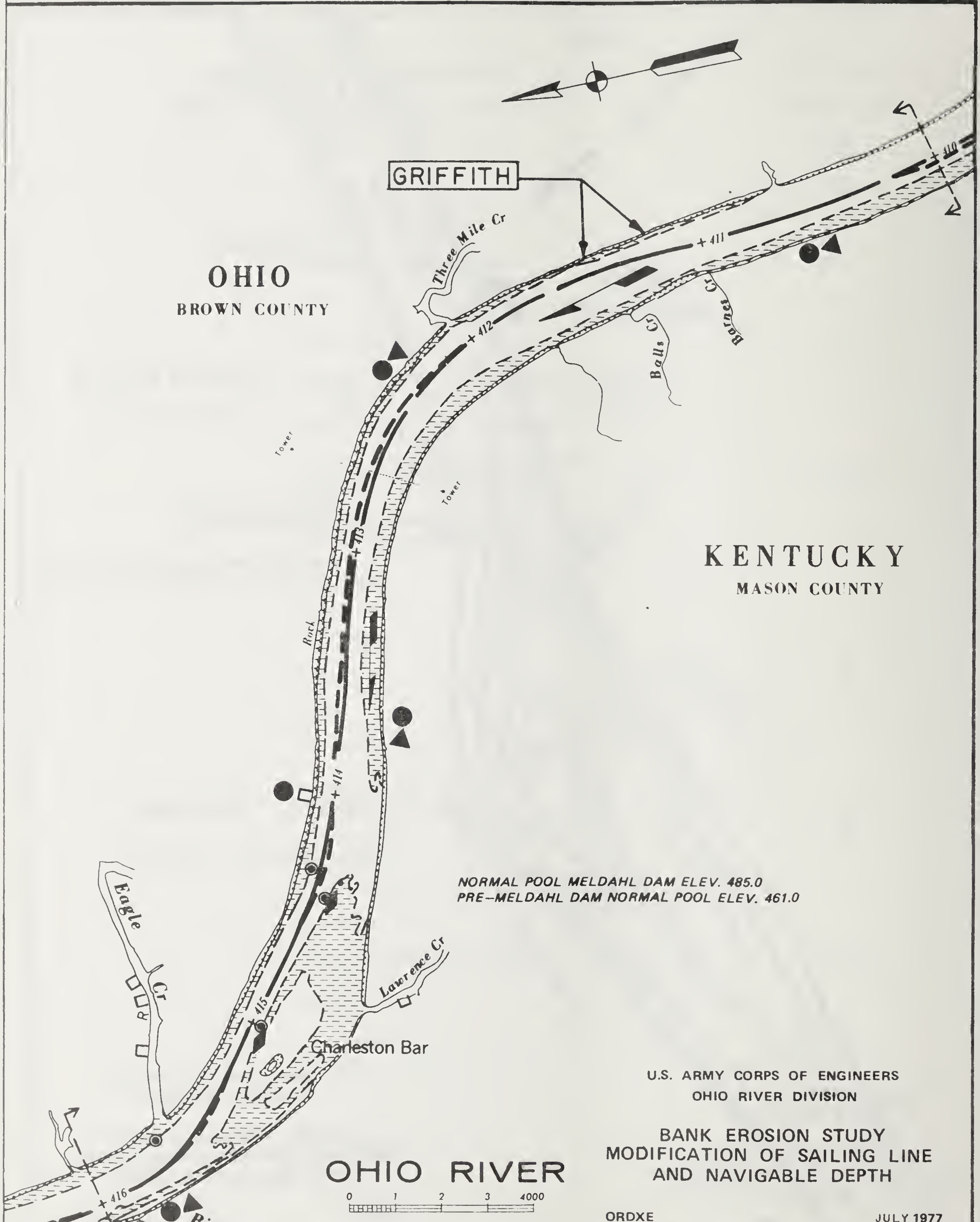

Rocky Bank
393
Gilpins Run
Pences Run
OHIO
ADAMS COUNTY
394
KENTUCKY
LEWIS COUNTY
Toles Cr
Lindseys Cr
CUNNINGHAM
NORMAL POOL MELDAHL DAM ELEV. 485.0
PRE-MELDAHL DAM NORMAL POOL ELEV. 468.0
395
Island Cr
R
OHIO RIVER
0 1 2 3 4000'
Manchester Island No. 2 (Ky.)
396
Manchester Island No. 1 (Ky.)
397
U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY
MODIFICATION OF SAILING LINE
AND NAVIGABLE DEPTH
ORDXE
JULY 1977

PLATE II

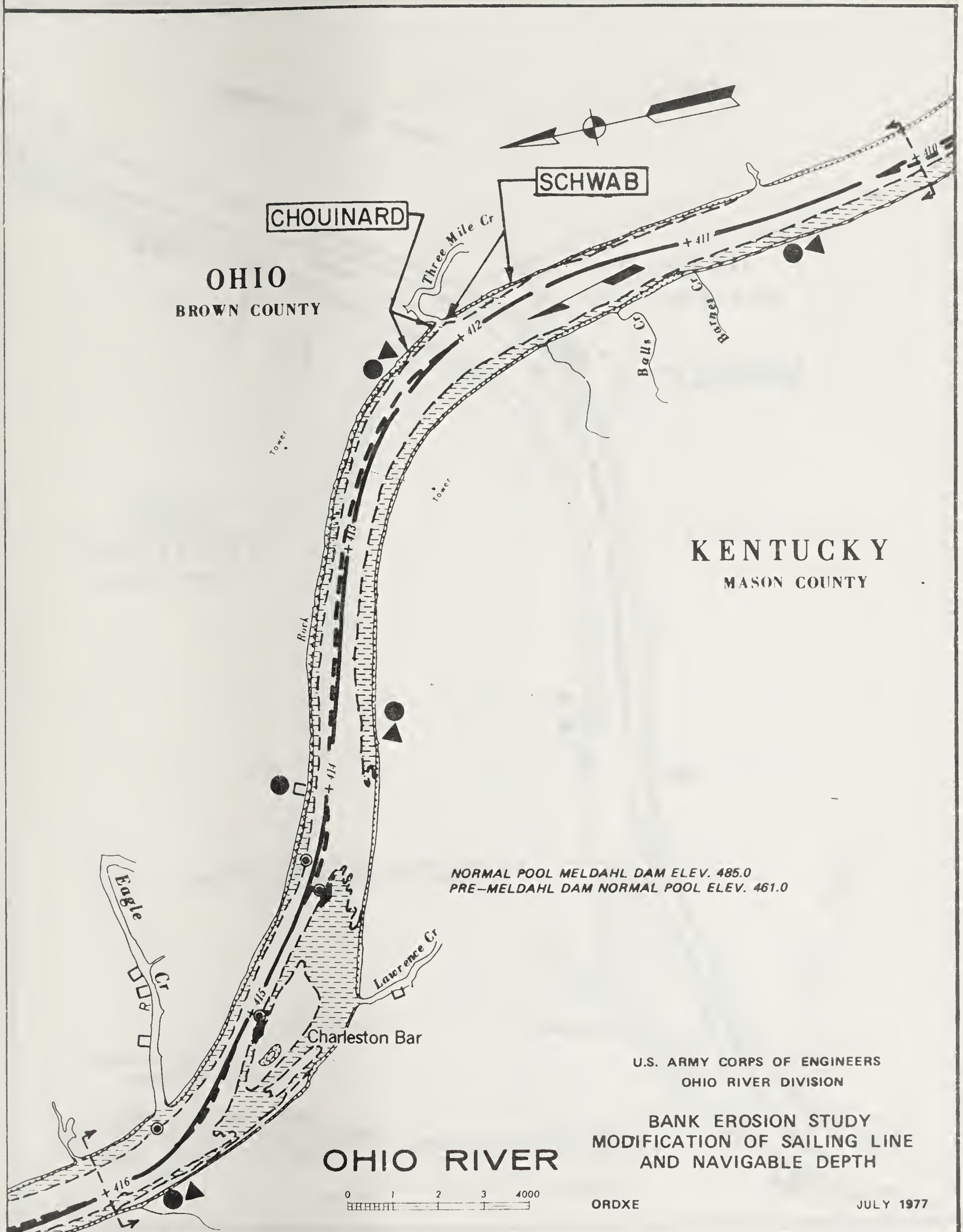


U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION

BANK EROSION STUDY
MODIFICATION OF SAILING LINE
AND NAVIGABLE DEPTH

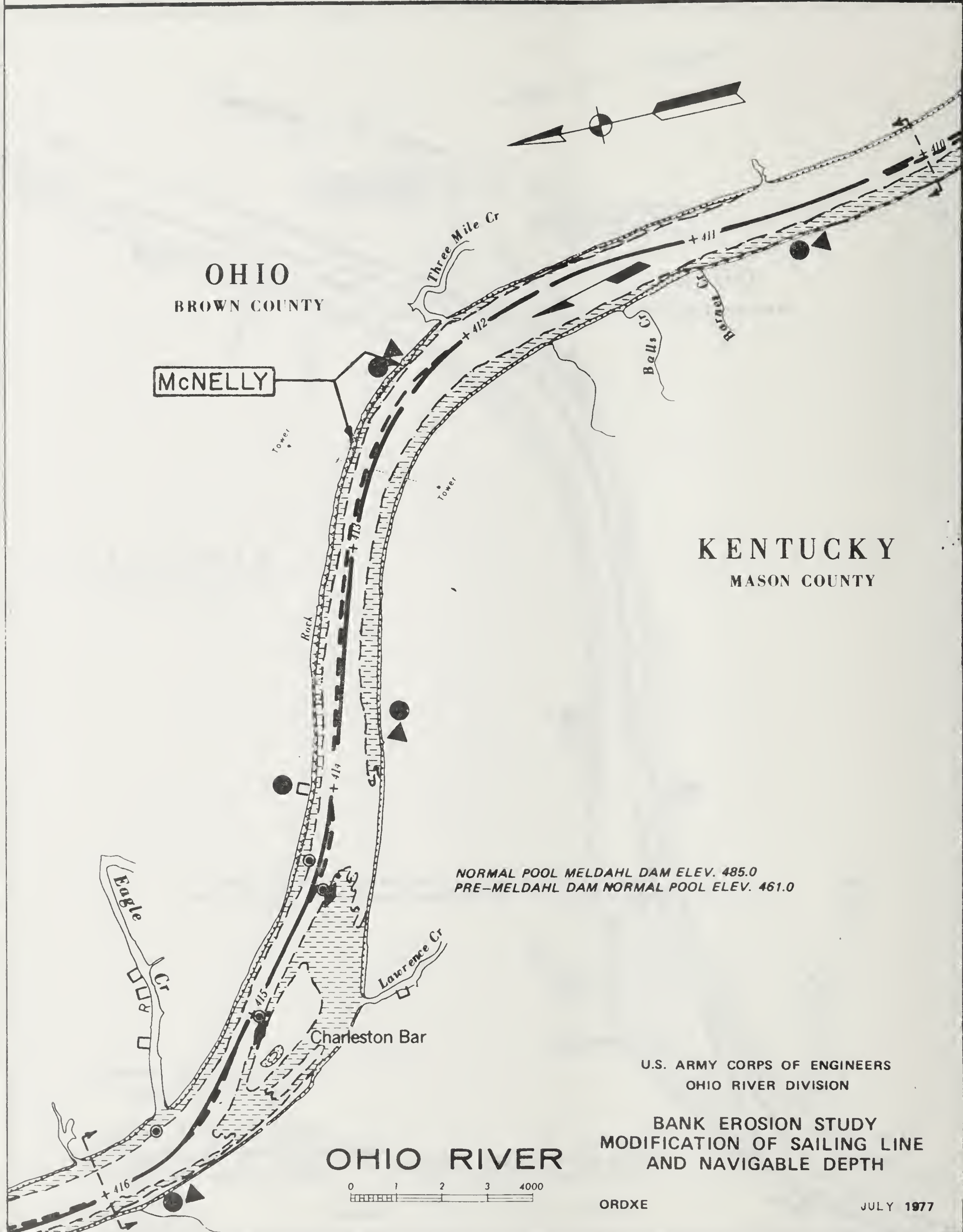
ORDXE JULY 1977

PLATE 12



SCHWAB
CHOUINARD
Three Mile Cr
OHIO
BROWN COUNTY
+411
+412
+413
+414
+415
+416
Balls Cr
Barnes Cr
Tower
Tower
KENTUCKY
MASON COUNTY
Rock
Eagle
Cr
Lawrence Cr
Charleston Bar
NORMAL POOL MELDAHL DAM ELEV. 485.0
PRE-MELDAHL DAM NORMAL POOL ELEV. 461.0
U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY
MODIFICATION OF SAILING LINE
AND NAVIGABLE DEPTH
OHIO RIVER
0 1 2 3 4000
ORDXE
JULY 1977

PLATE 13



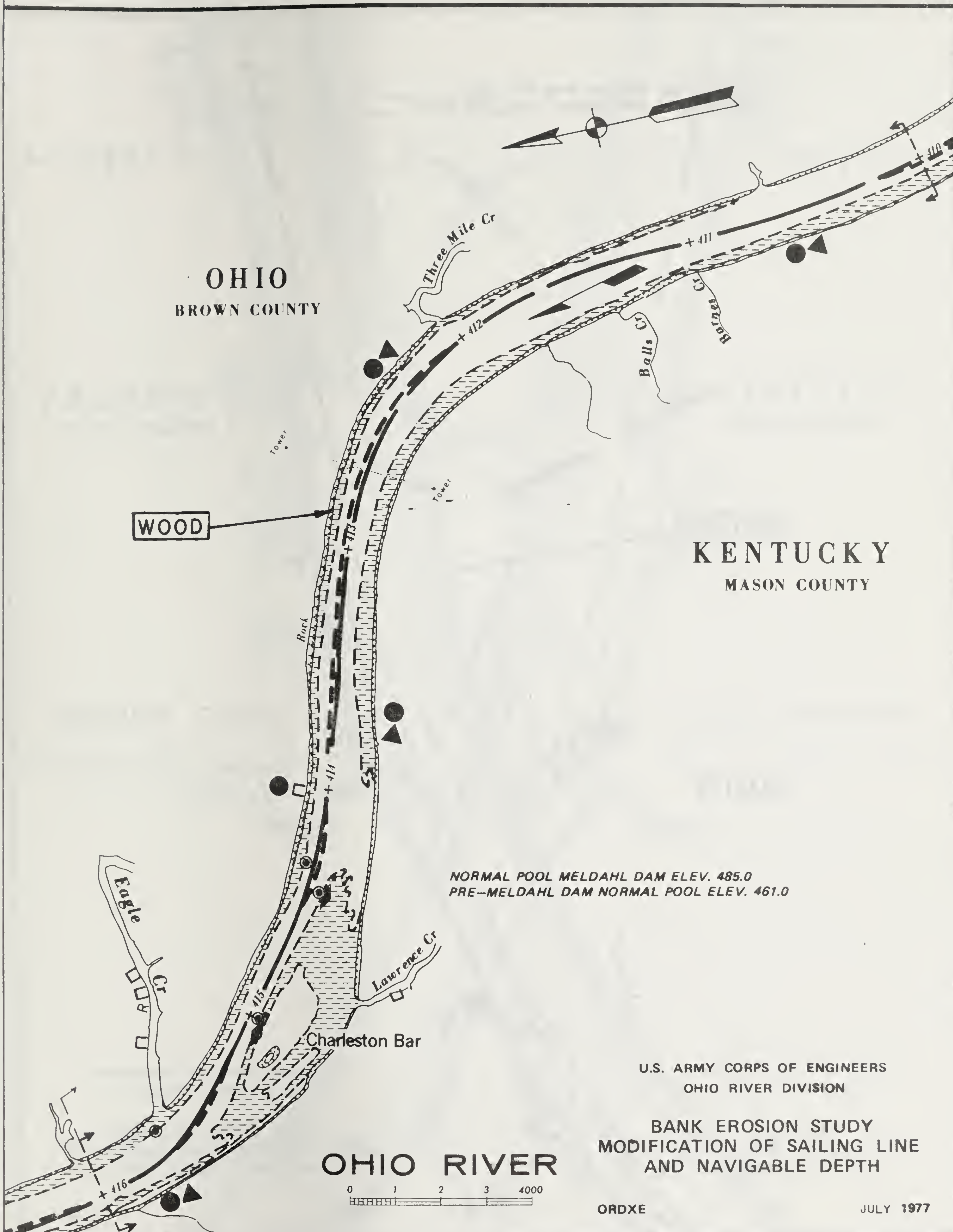
U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION

BANK EROSION STUDY
MODIFICATION OF SAILING LINE
AND NAVIGABLE DEPTH

ORDXE

JULY 1977

PLATE 14



OHIO
BROWN COUNTY
Three Mile Cr
+410
+411
+412
+413
+414
+415
+416
Balls Cr
Barnes Cr
Tower
Tower
WOOD
Rock
KENTUCKY
MASON COUNTY
NORMAL POOL MELDAHL DAM ELEV. 485.0
PRE–MELDAHL DAM NORMAL POOL ELEV. 461.0
Eagle Cr
Lawrence Cr
Charleston Bar
OHIO RIVER
0 1 2 3 4000
U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY
MODIFICATION OF SAILING LINE
AND NAVIGABLE DEPTH
ORDXE
JULY 1977

PLATE 15

NORMAL POOL MELDAHL DAM ELEV. 485.0
PRE-MELDAHL DAM NORMAL POOL ELEV. 461.0
FERRY
Augusta
Moon Hollow Run
428
KENTUCKY
BRACKEN COUNTY
Big Turtle Cr
POSTON
429
OHIO RIVER
0 1 2 3 4000'
BROWN CO
CLERMONT CO
OHIO
Fanny Owens Gut
430
Wrangling Run
431
U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY
MODIFICATION OF SAILING LINE
AND NAVIGABLE DEPTH
ORDXE
JULY 1977

PLATE 16

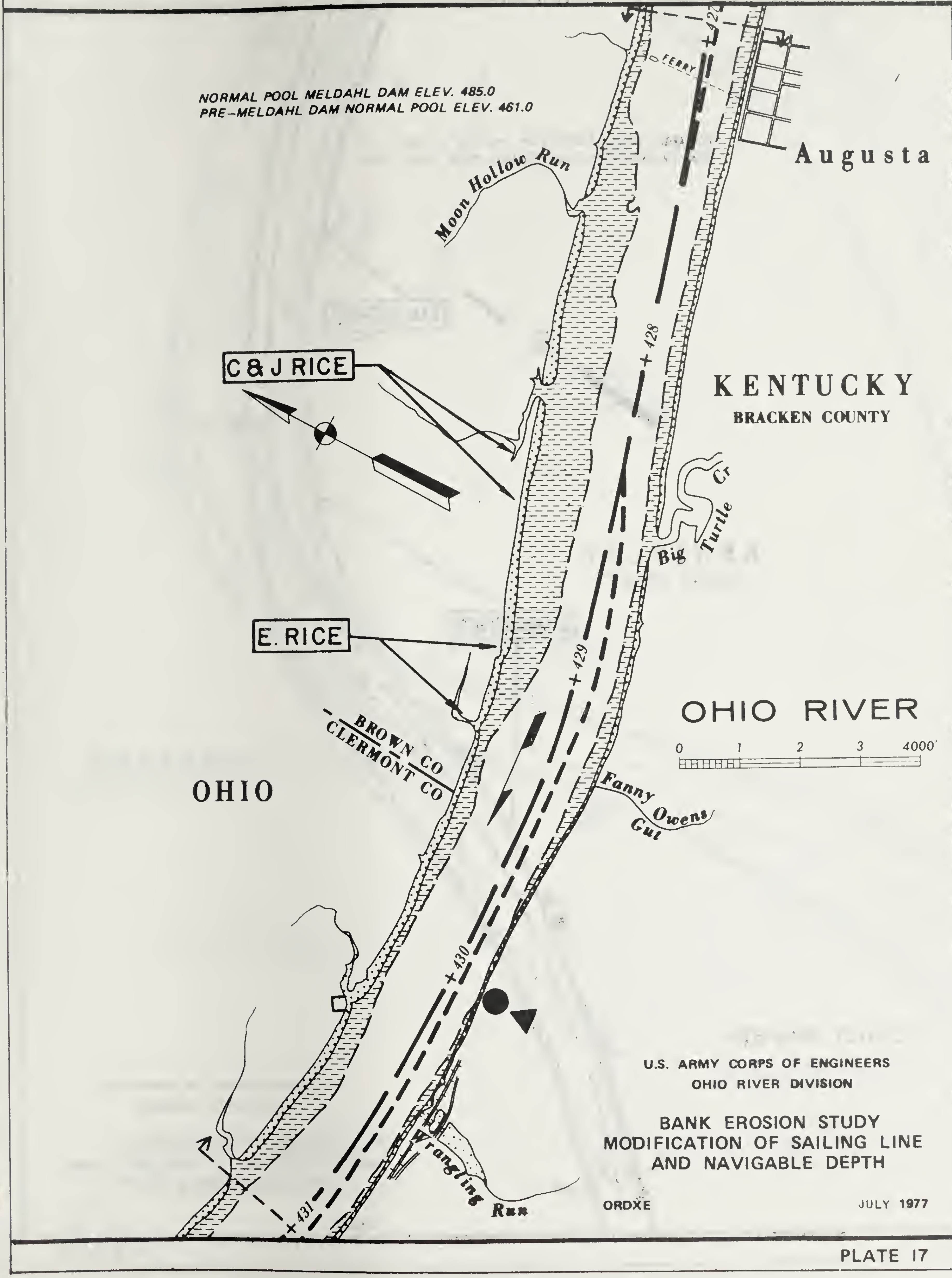

NORMAL POOL MELDAHL DAM ELEV. 485.0
PRE-MELDAHL DAM NORMAL POOL ELEV. 461.0
FERRY
Augusta
Moon Hollow Run
C & J RICE
+428
KENTUCKY
BRACKEN COUNTY
Big Turtle Cr
E. RICE
+429
OHIO RIVER
0 1 2 3 4000'
BROWN CO
CLERMONT CO
OHIO
Fanny Owens Gut
+430
Wrangling Run
+431
U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY
MODIFICATION OF SAILING LINE
AND NAVIGABLE DEPTH
ORDXE
JULY 1977

PLATE 17

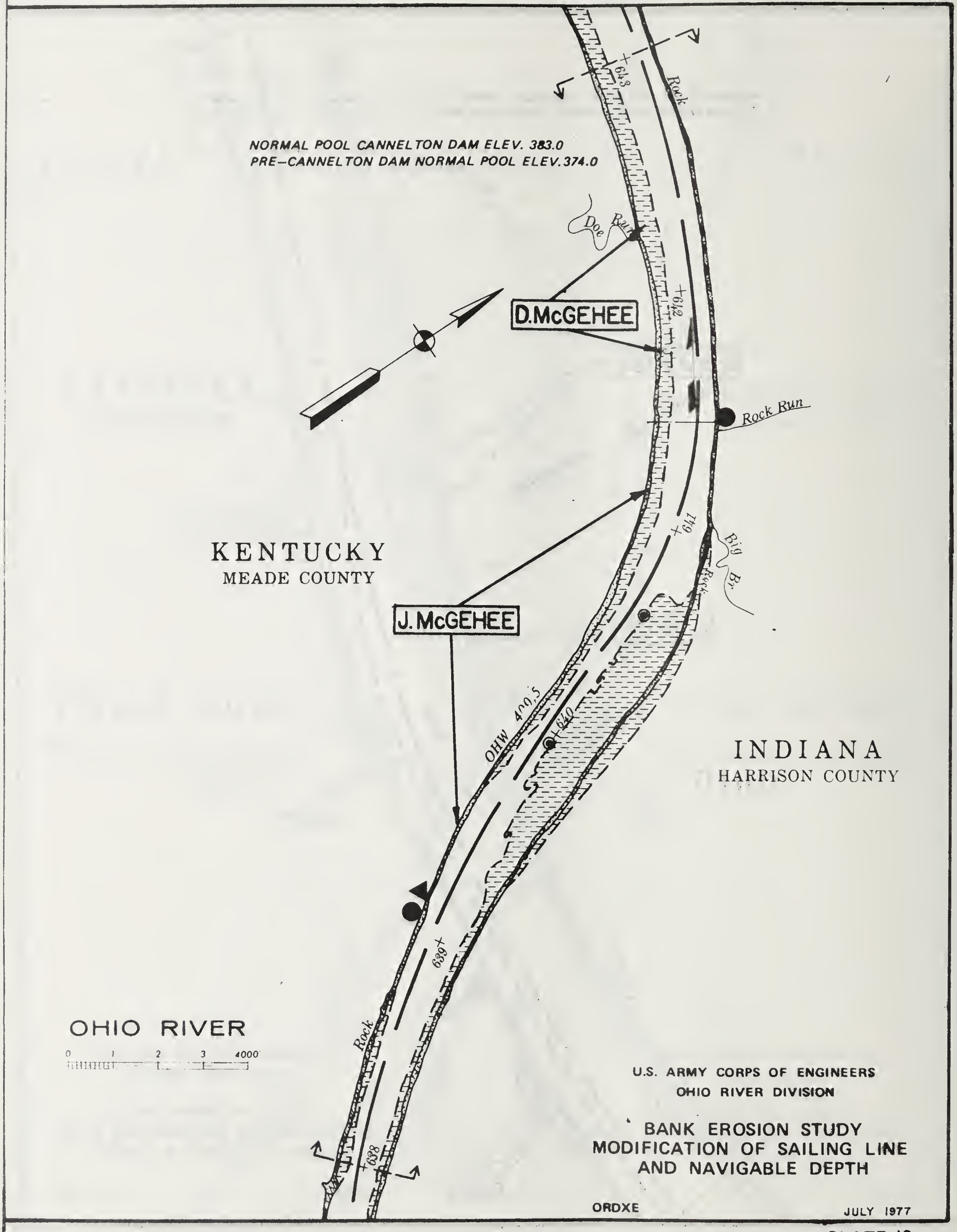
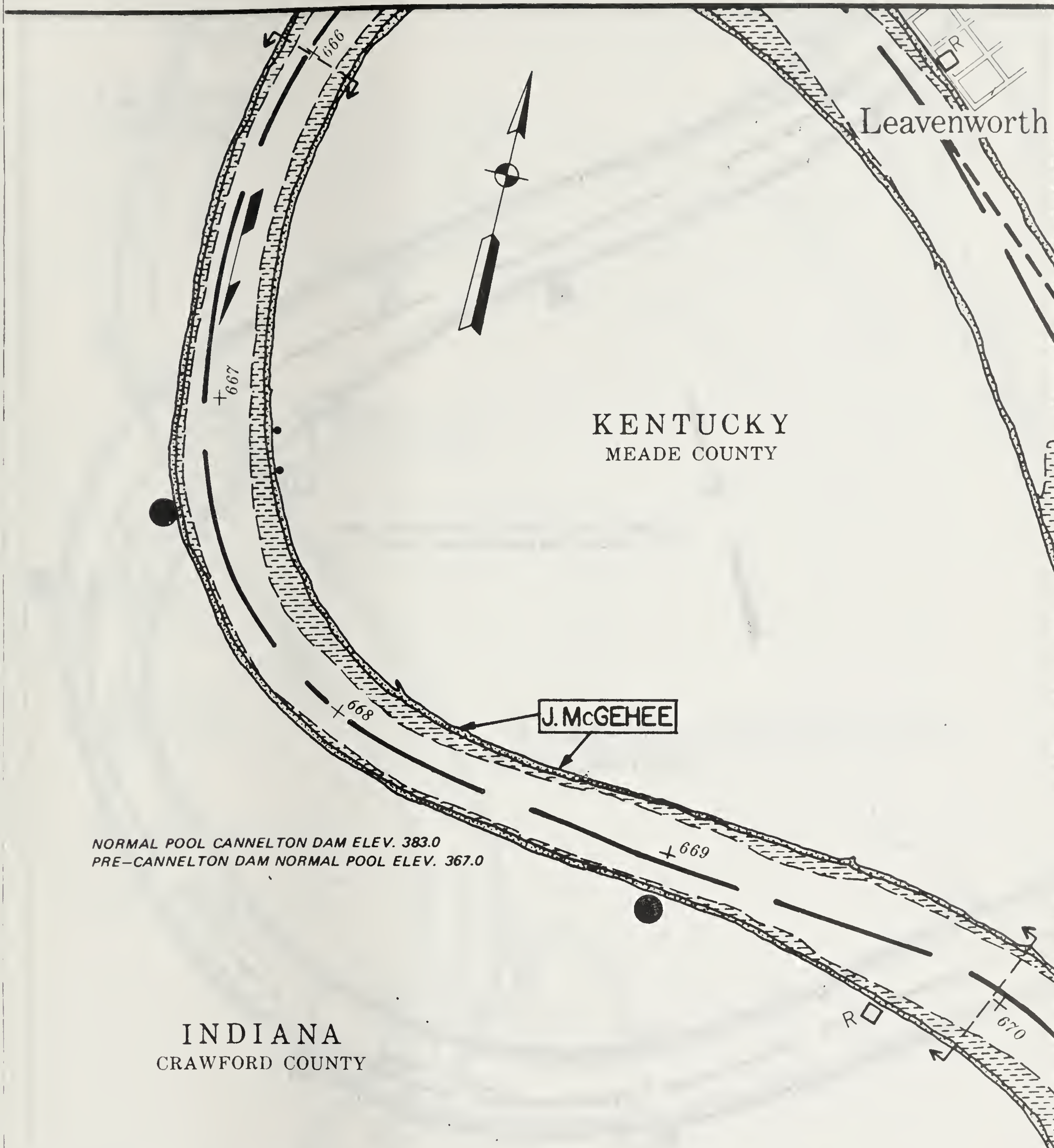

NORMAL POOL CANNELTON DAM ELEV. 383.0
PRE-CANNELTON DAM NORMAL POOL ELEV. 374.0
643
Rock
Doe Run
D.McGEHEE
642
Rock Run
641
Big Br.
Rock
KENTUCKY
MEADE COUNTY
J. McGEHEE
OHW 400.5
640
INDIANA
HARRISON COUNTY
639
Rock
638
OHIO RIVER
0 1 2 3 4000
U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY
MODIFICATION OF SAILING LINE
AND NAVIGABLE DEPTH
ORDXE
JULY 1977

PLATE 18



U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION

BANK EROSION STUDY
MODIFICATION OF SAILING LINE
AND NAVIGABLE DEPTH

ORDXE JULY 1977

PLATE 19

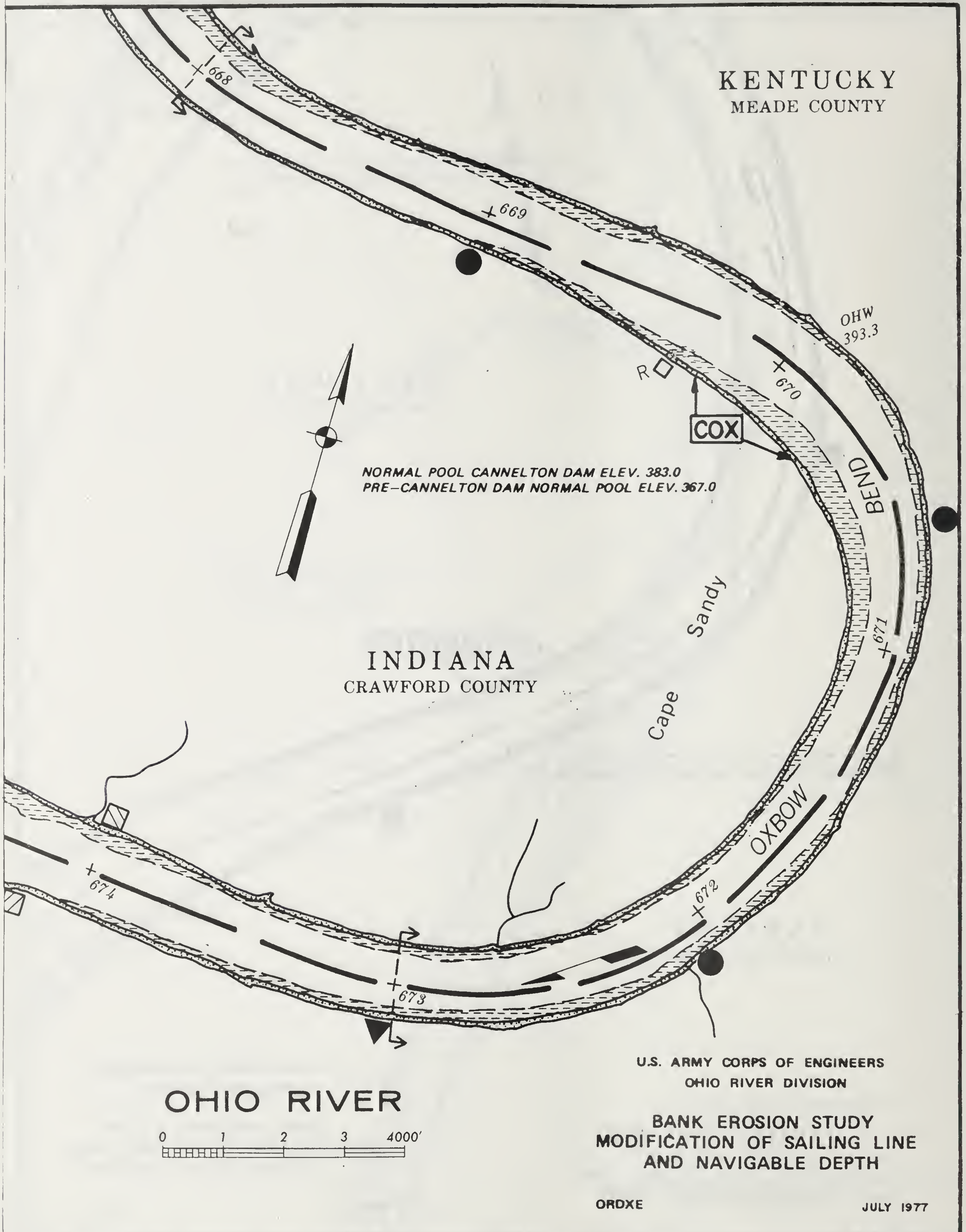
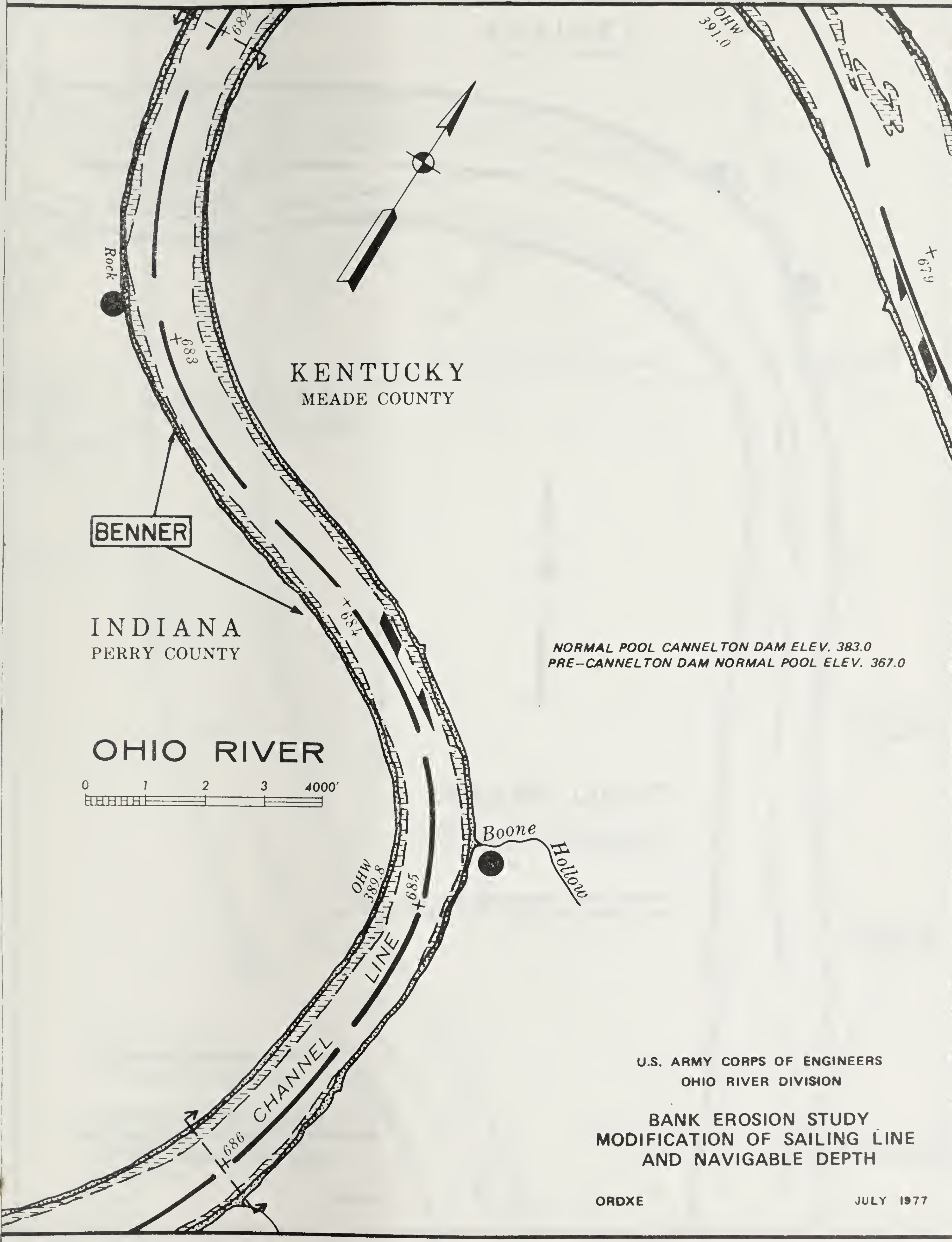
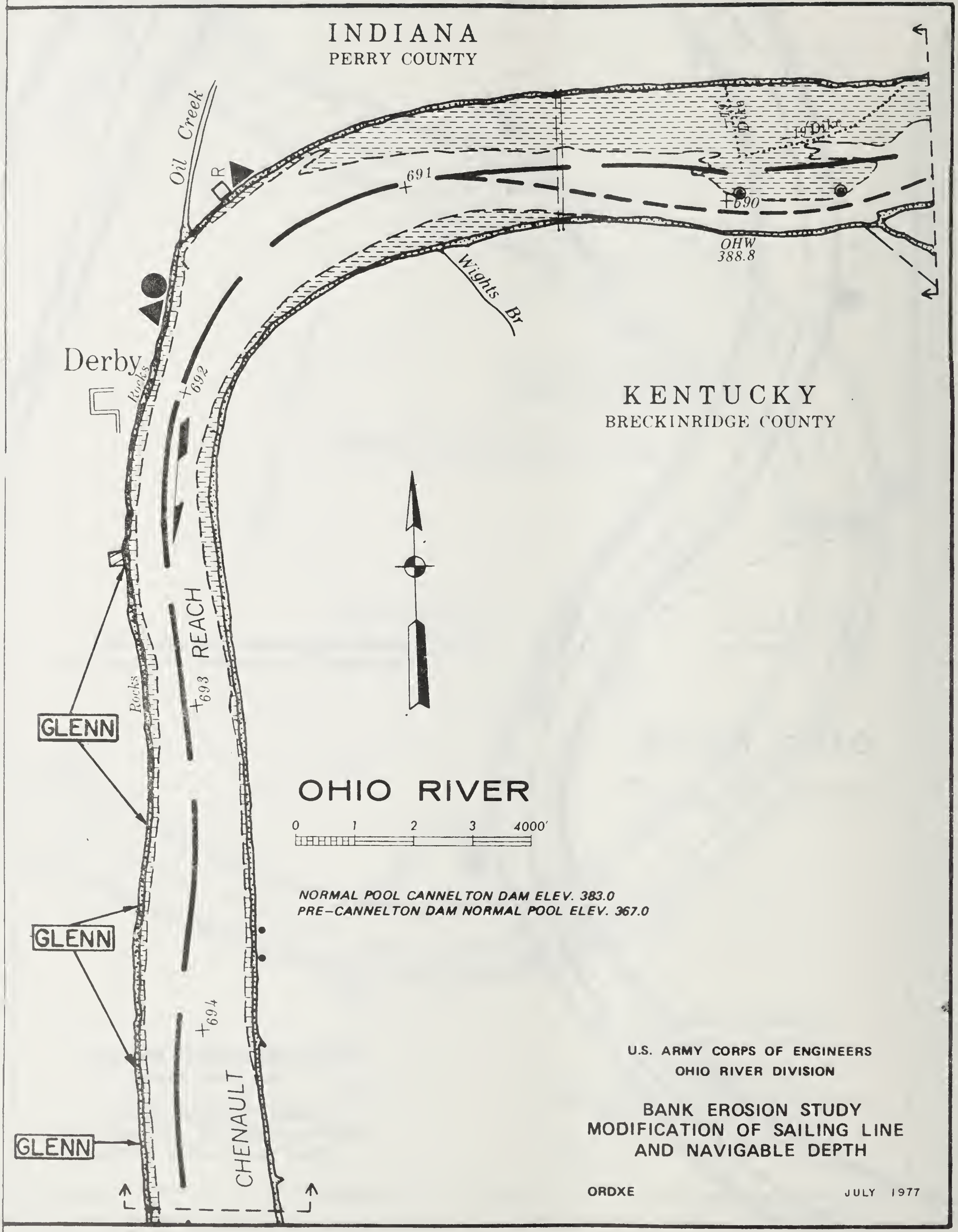

KENTUCKY
MEADE COUNTY
668
669
OHW
393.3
670
R
COX
NORMAL POOL CANNELTON DAM ELEV. 383.0
PRE-CANNELTON DAM NORMAL POOL ELEV. 367.0
BEND
Sandy
Cape
671
INDIANA
CRAWFORD COUNTY
OXBOW
674
672
673
OHIO RIVER
0
1
2
3
4000'
U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY
MODIFICATION OF SAILING LINE
AND NAVIGABLE DEPTH
ORDXE
JULY 1977

PLATE 20



OHW 391.0
682
679
Rock
683
KENTUCKY
MEADE COUNTY
BENNER
INDIANA
PERRY COUNTY
684
NORMAL POOL CANNELTON DAM ELEV. 383.0
PRE–CANNELTON DAM NORMAL POOL ELEV. 367.0
OHIO RIVER
0 1 2 3 4000'
Boone
Hollow
OHW 389.8
685
CHANNEL LINE
686
U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY
MODIFICATION OF SAILING LINE
AND NAVIGABLE DEPTH
ORDXE
JULY 1977

PLATE 21


INDIANA
PERRY COUNTY
Oil Creek
R
691
690
OHW
388.8
19 Dike
Wights Br
Derby
Rocks
692
KENTUCKY
BRECKINRIDGE COUNTY
REACH
693
Rocks
GLENN
GLENN
GLENN
694
CHENAULT
OHIO RIVER
0 1 2 3 4000'
NORMAL POOL CANNELTON DAM ELEV. 383.0
PRE-CANNELTON DAM NORMAL POOL ELEV. 367.0
U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY
MODIFICATION OF SAILING LINE
AND NAVIGABLE DEPTH
ORDXE
JULY 1977

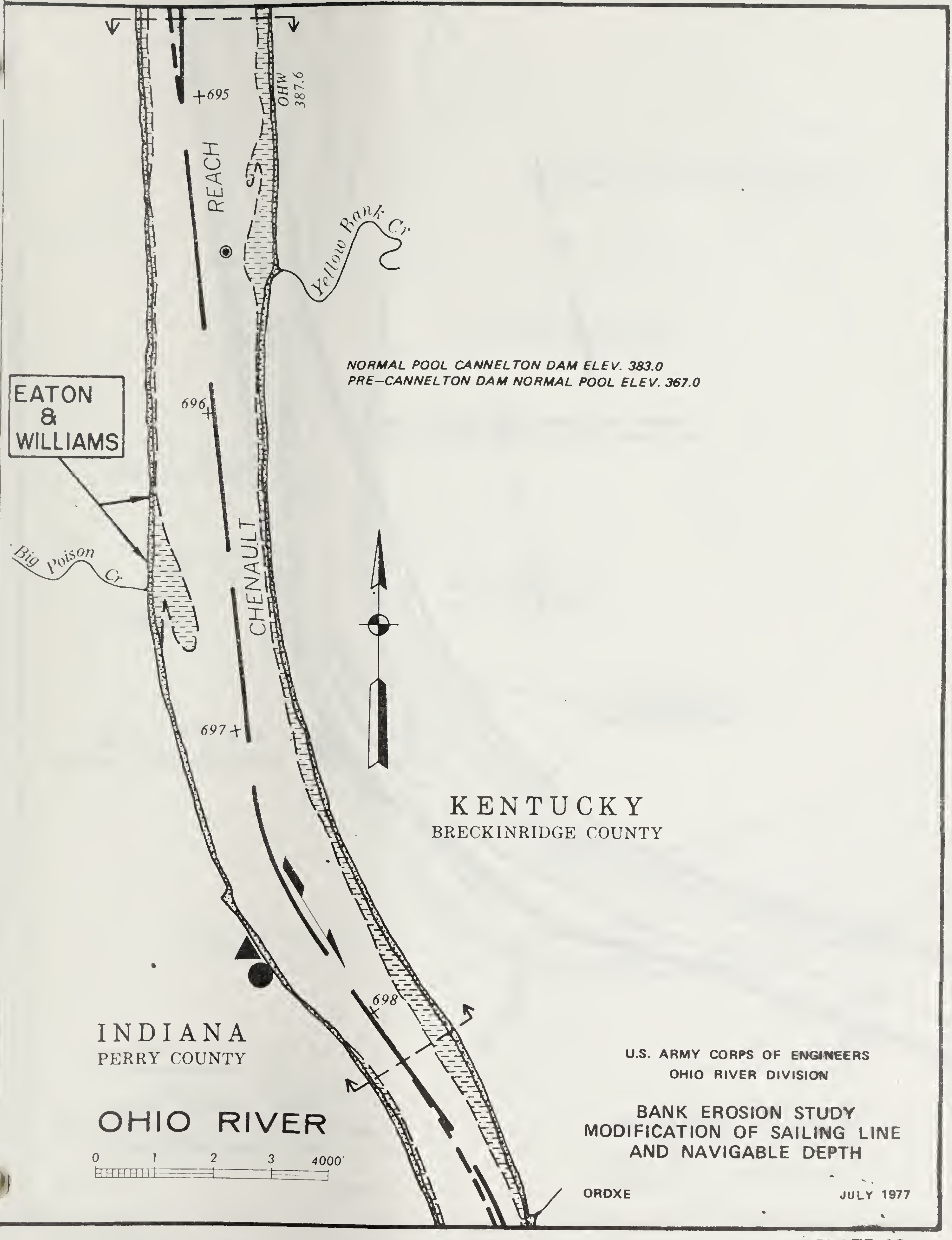

+695
OHW 387.6
REACH
Yellow Bank Cr
NORMAL POOL CANNELTON DAM ELEV. 383.0
PRE-CANNELTON DAM NORMAL POOL ELEV. 367.0
EATON & WILLIAMS
696
Big Poison Cr
CHENAULT
697
KENTUCKY
BRECKINRIDGE COUNTY
698
INDIANA
PERRY COUNTY
OHIO RIVER
0 1 2 3 4000′
U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY
MODIFICATION OF SAILING LINE
AND NAVIGABLE DEPTH
ORDXE
JULY 1977

PLATE 23

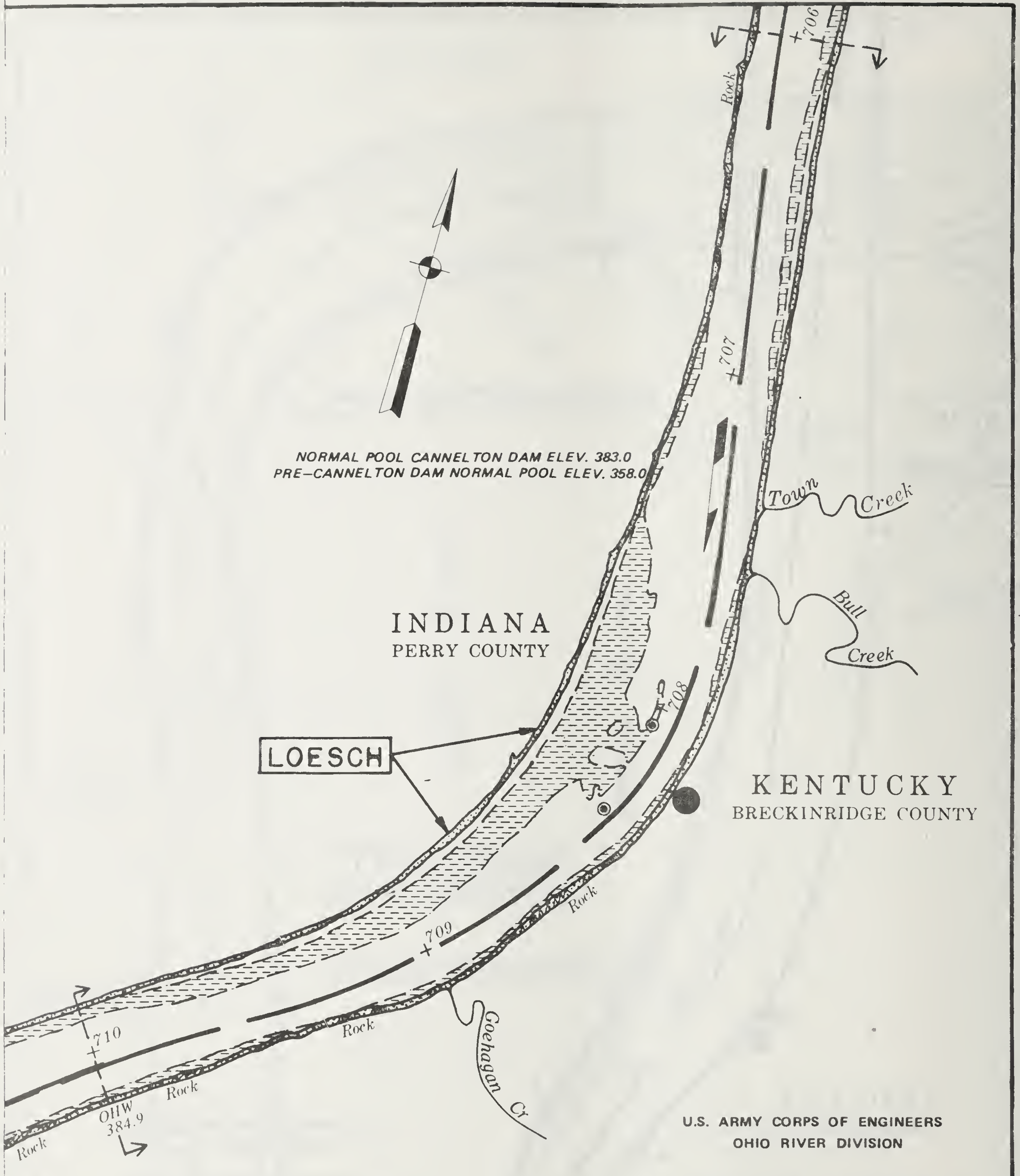
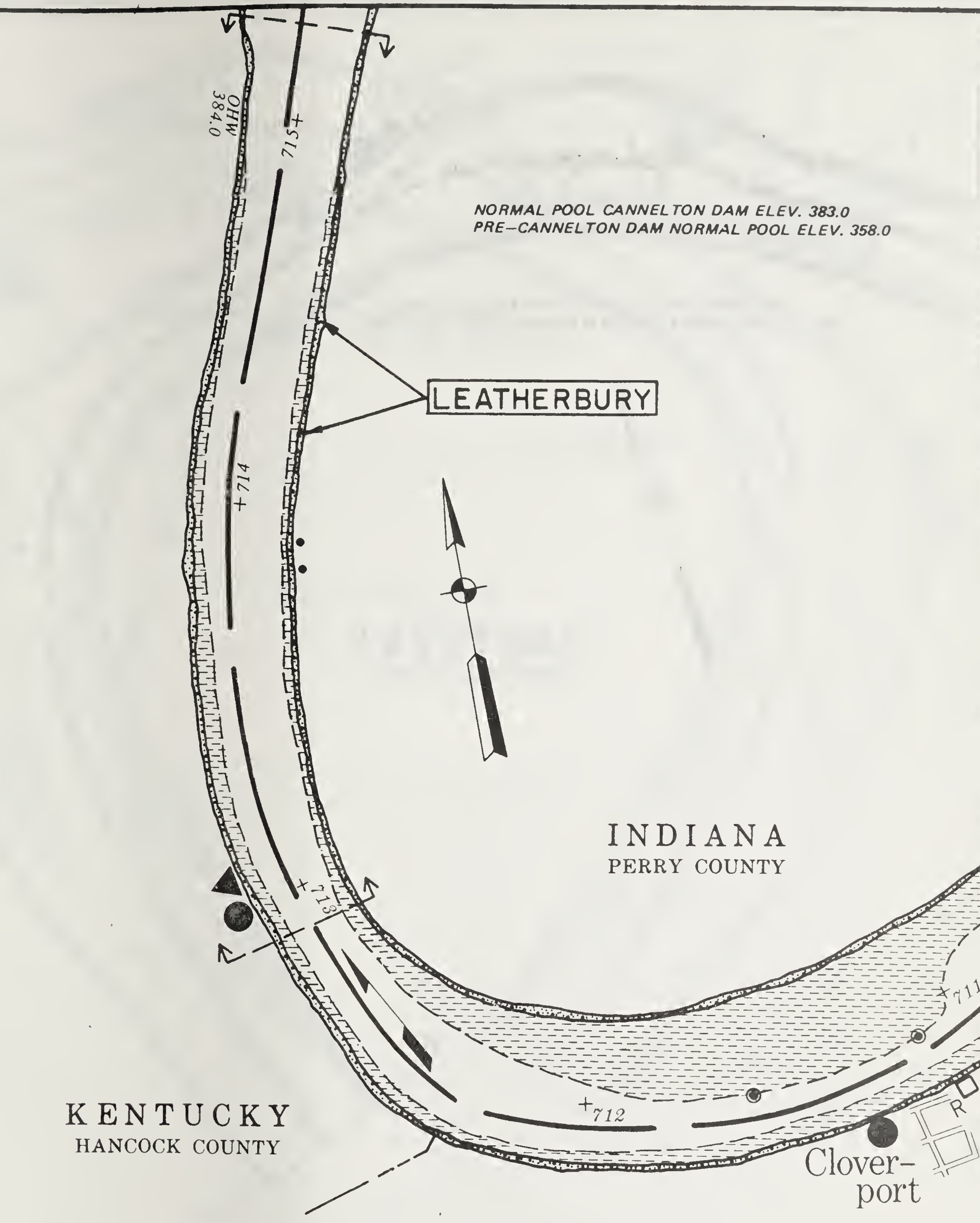

706
707
708
709
710
Rock
NORMAL POOL CANNELTON DAM ELEV. 383.0
PRE-CANNELTON DAM NORMAL POOL ELEV. 358.0
Town Creek
Bull Creek
INDIANA
PERRY COUNTY
LOESCH
KENTUCKY
BRECKINRIDGE COUNTY
Goehagan Cr.
OHW
384.9
OHIO RIVER
0 1 2 3 4000'
U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY
MODIFICATION OF SAILING LINE
AND NAVIGABLE DEPTH
ORDXE
JULY 1977

PLATE 24



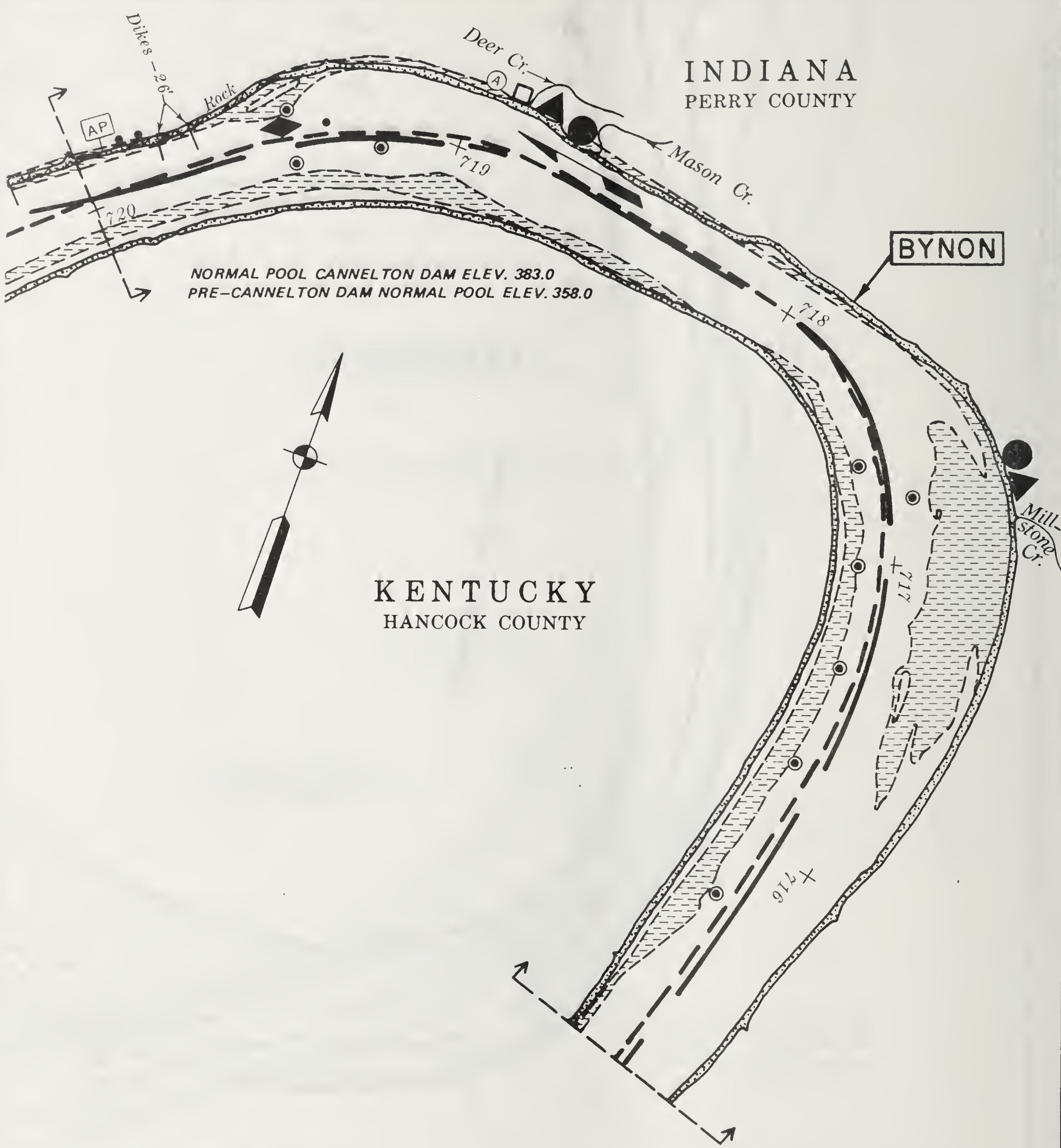
OHIO RIVER

0 1 2 3 4000'

U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION

BANK EROSION STUDY
MODIFICATION OF SAILING LINE
AND NAVIGABLE DEPTH

ORDXE JULY 1977



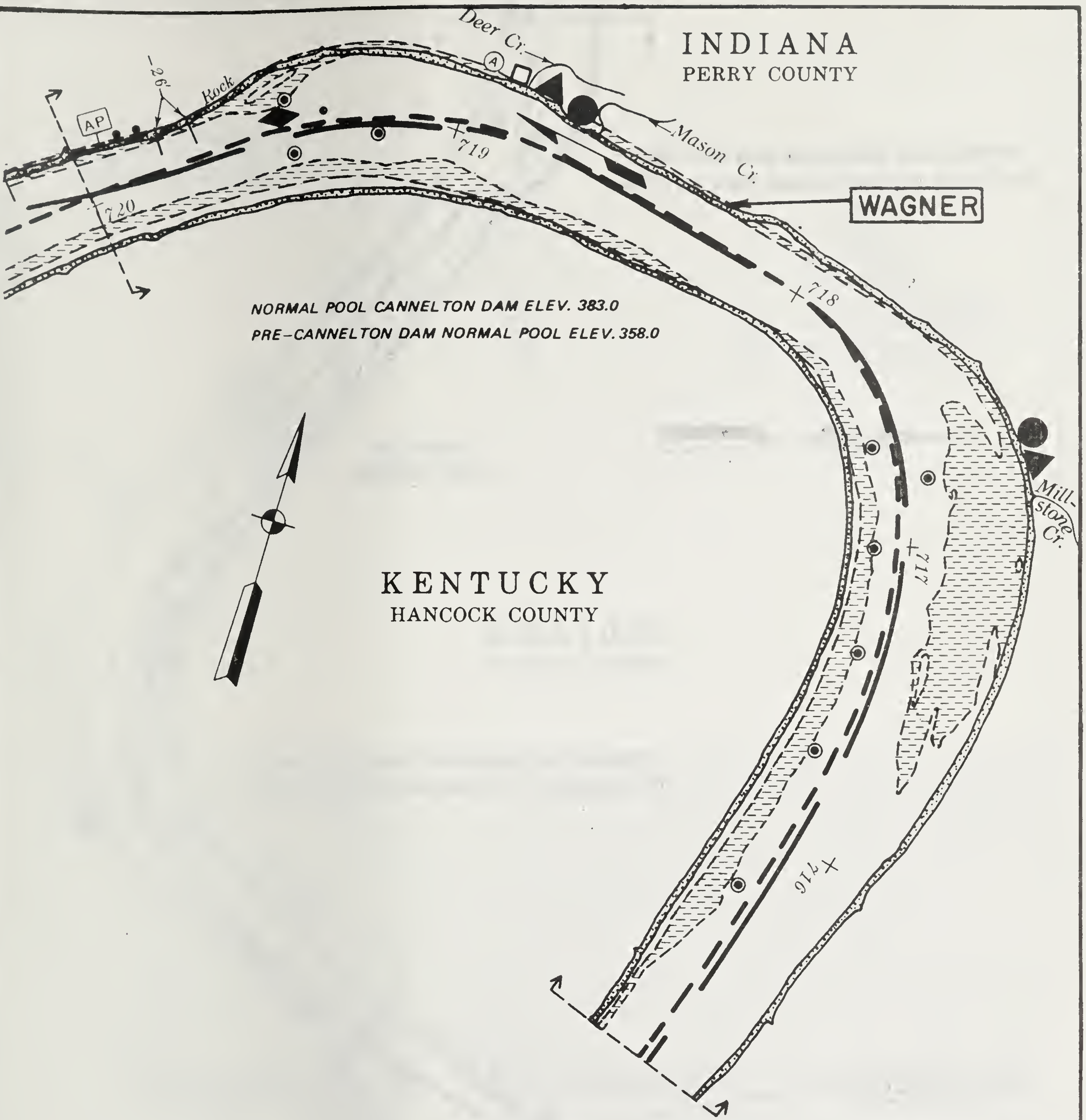
U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION

OHIO RIVER

BANK EROSION STUDY
MODIFICATION OF SAILING LINE
AND NAVIGABLE DEPTH

ORDXE

JULY 1977



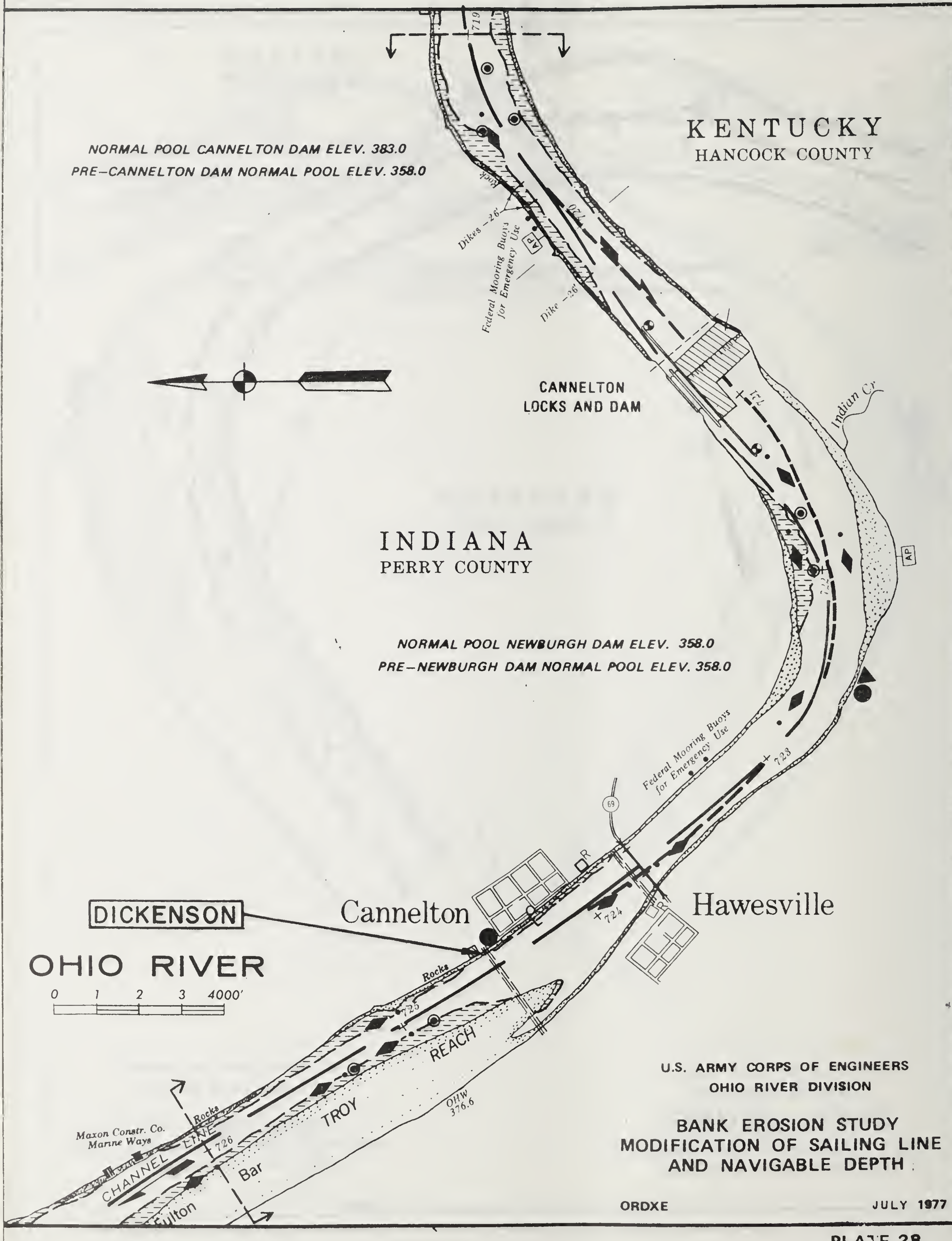
OHIO RIVER

0 1 2 3 4000'

U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION

BANK EROSION STUDY
MODIFICATION OF SAILING LINE
AND NAVIGABLE DEPTH

ORDXE JULY 1977



NORMAL POOL CANNELTON DAM ELEV. 383.0
PRE-CANNELTON DAM NORMAL POOL ELEV. 358.0
KENTUCKY
HANCOCK COUNTY
719
720
721
722
723
724
725
726
Rock
Dikes -26'
Dike -26'
Federal Mooring Buoys for Emergency Use
AP
CANNELTON LOCKS AND DAM
Indian Cr
INDIANA
PERRY COUNTY
NORMAL POOL NEWBURGH DAM ELEV. 358.0
PRE-NEWBURGH DAM NORMAL POOL ELEV. 358.0
69
Cannelton
Hawesville
DICKENSON
OHIO RIVER
0 1 2 3 4000'
Rocks
TROY REACH
OHW 376.6
CHANNEL LINE
Maxon Constr. Co. Marine Ways
Fulton Bar
U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY
MODIFICATION OF SAILING LINE AND NAVIGABLE DEPTH
ORDXE
JULY 1977

PLATE 28

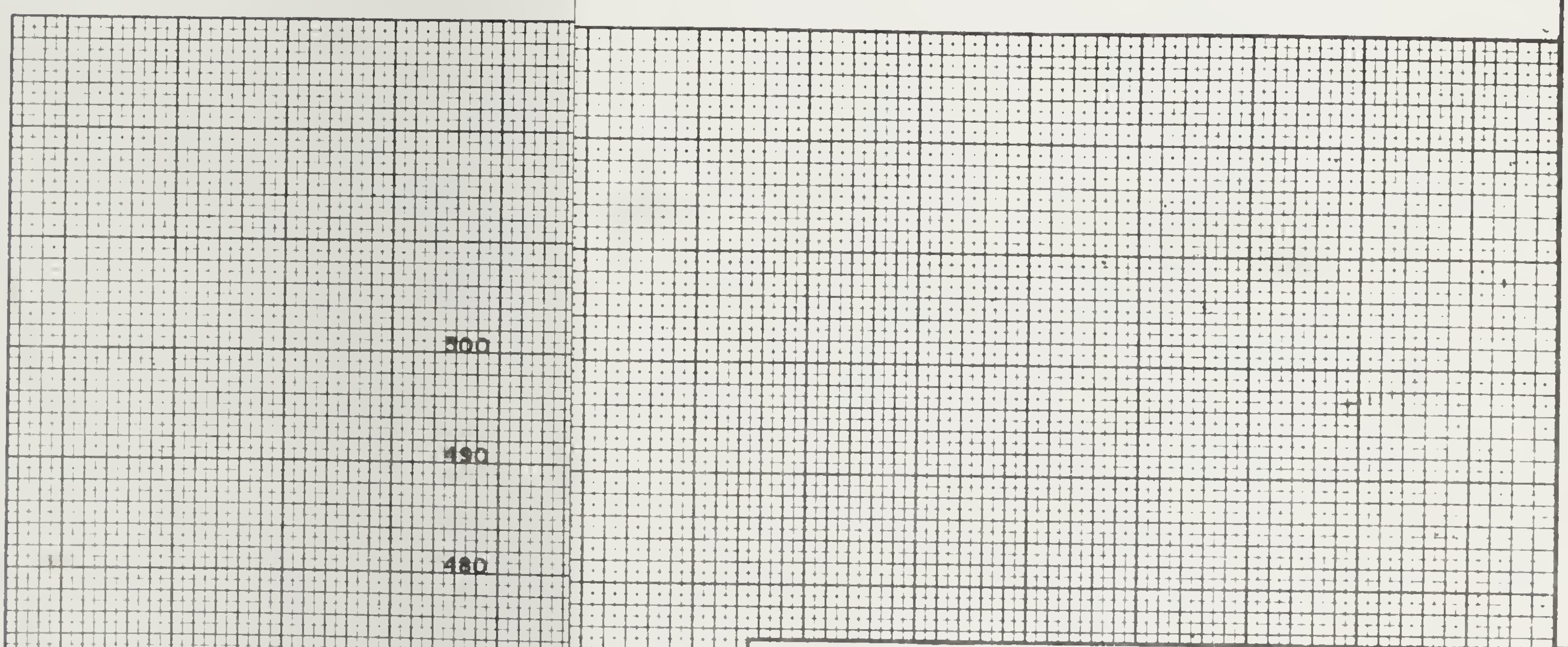
MAPPING BASED ON 22 MAR.77 PHOTOGRAPHY

LEGEND

- 1977 FIELD SECTION
- 1959 MAPPING "
- VELOCITY CROSS SECTION
- WAVE MEASUREMENT SITE
- SOIL SAMPLING SITE
- PHOTOGRAPH LOCATION

FINAL SURVEY	SURVEYED	BY	DATE
NOTE BOOK	PLOTTED		
NO	TEMPLATE		
	AREAS		
	AREAS CHECKED		

ORIGINAL SURVEY	SURVEYED	BY	DATE
NOTE BOOK	PLOTTED		
NO	TEMPLATE		
	AREAS		
	AREAS CHECKED		



U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

MELDAHL POOL

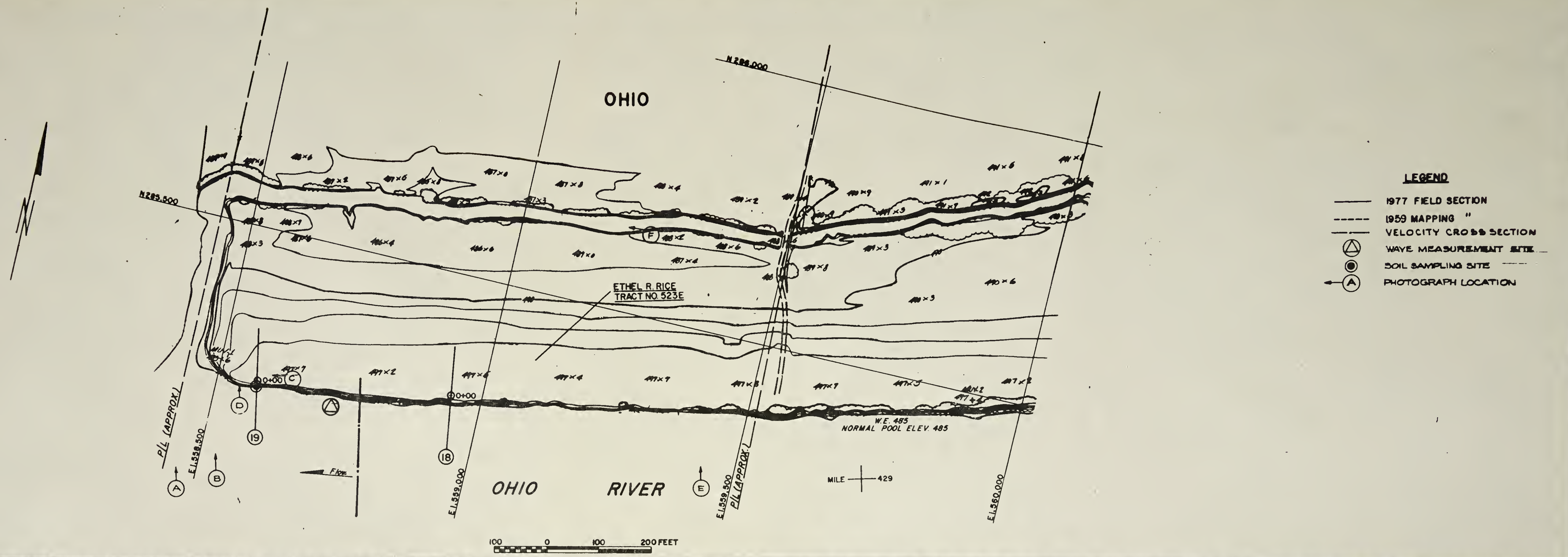
ETHEL RICE, TRACT NO. 523E

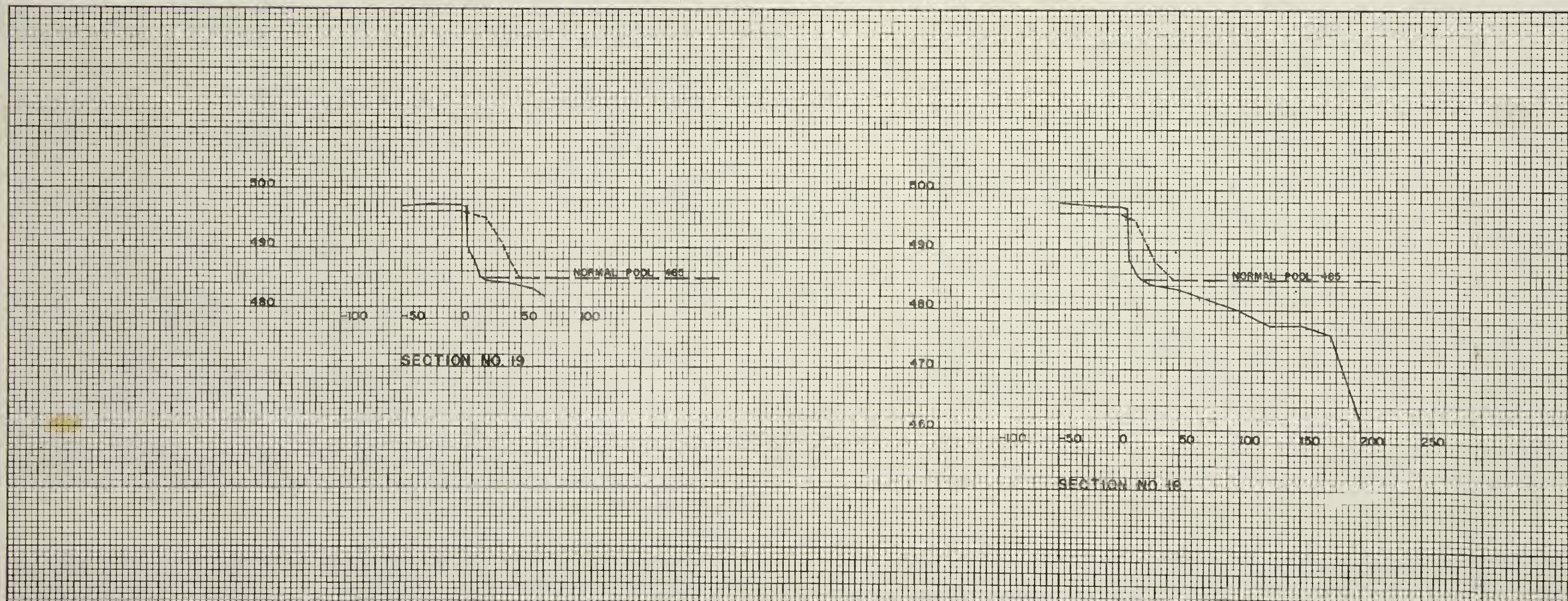
PLAN AND SECTIONS

MILE 429.1

ORDXE JULY 77

MAPPING BASED ON 22 MAR.77 PHOTOGRAPHY





U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY

MELDAHL POOL

ETHEL RICE, TRACT NO. 523E
PLAN AND SECTIONS
MILE 429.1

ORDXE JULY 77

PLATE 29

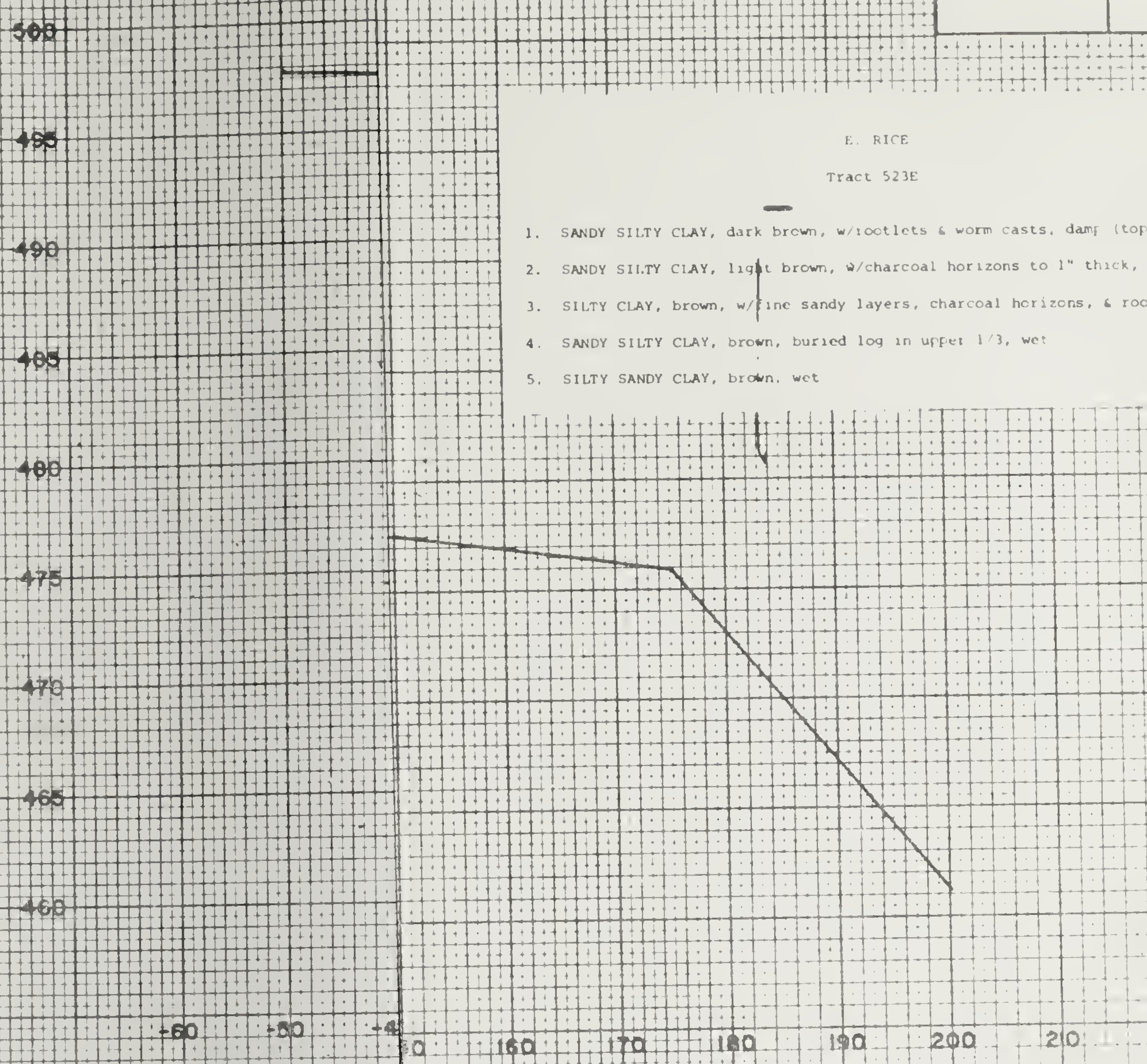
SHEET 1 OF 2

COUNTY OF	FISCAL YEAR	SHEET NO	TOTAL SHEETS

E. RICE

Tract 523E

1. SANDY SILTY CLAY, dark brown, w/rootlets & worm casts, damp (topsoil)
2. SANDY SILTY CLAY, light brown, w/charcoal horizons to 1" thick, rootlets, damp
3. SILTY CLAY, brown, w/fine sandy layers, charcoal horizons, & rootlets, damp
4. SANDY SILTY CLAY, brown, buried log in upper 1/3, wet
5. SILTY SANDY CLAY, brown, wet



FINAL SURVEY	SURVEYED / PLOTTED / TEMPLATE / AREAS / AREAS CHECKED	BY	DATE
NOTE BOOK			
NO			

ORIGINAL SURVEY	SURVEYED / PLOTTED / TEMPLATE / AREAS / AREAS CHECKED	BY	DATE
NOTE BOOK			
NO			

U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

MELDAHL POOL

ETHYL RICE, TRACT NO. 523E

SOIL PROFILE

MILE 429.1

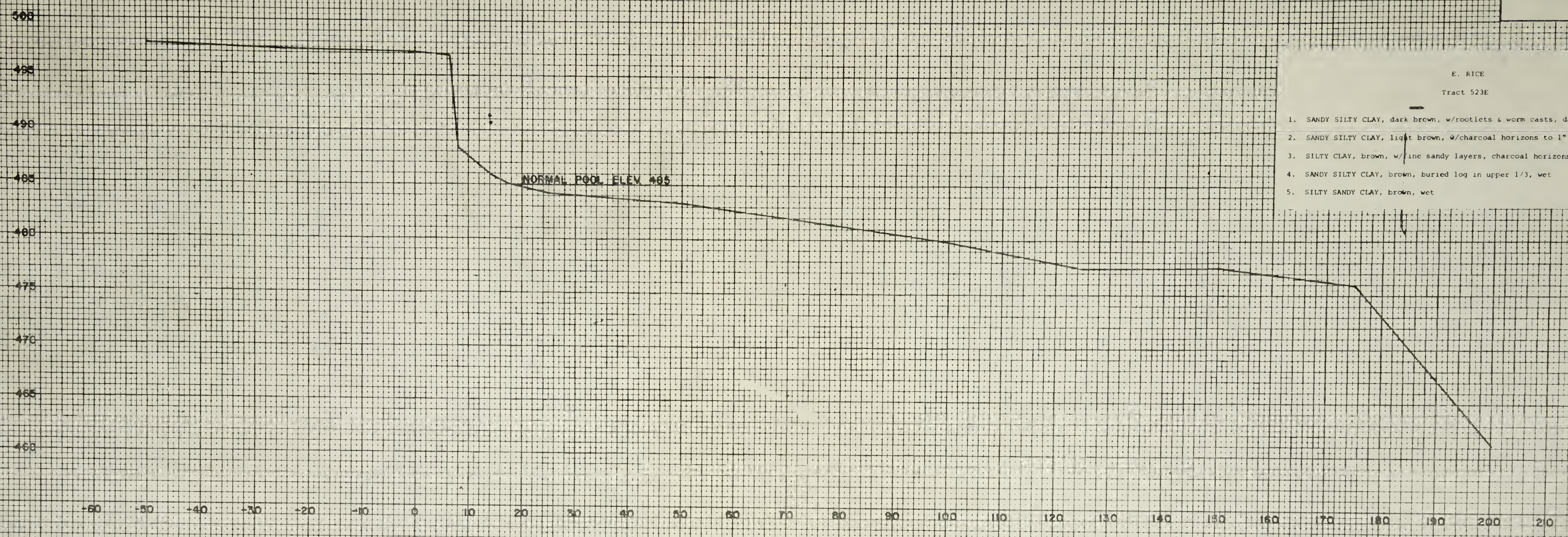
ORDXE JULY 77

COUNTY OF	FISCAL YEAR	SHEET NO	TOTAL SHEETS

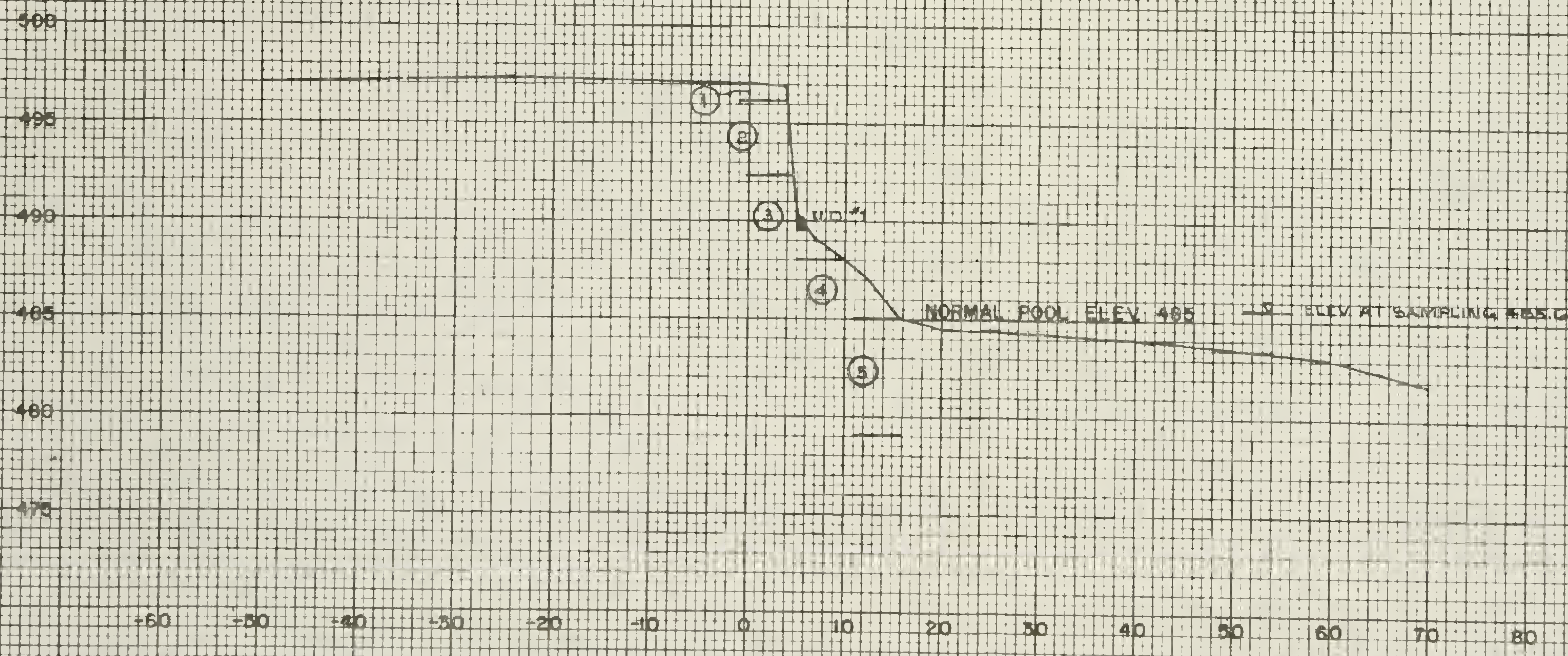
E. RICE

Tract 523E

1. SANDY SILTY CLAY, dark brown, w/rootlets & worm casts, damp (topsoil)
2. SANDY SILTY CLAY, light brown, w/charcoal horizons to 1" thick, rootlets, damp
3. SILTY CLAY, brown, w/fine sandy layers, charcoal horizons, & rootlets, damp
4. SANDY SILTY CLAY, brown, buried log in upper 1/3, wet
5. SILTY SANDY CLAY, brown, wet



SECTION NO. 18 (TRACT NO. 523E)
1977 FIELD SECTIONS



SECTION NO. 19 (TRACT NO. 523E)
1977 FIELD SECTION

U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY

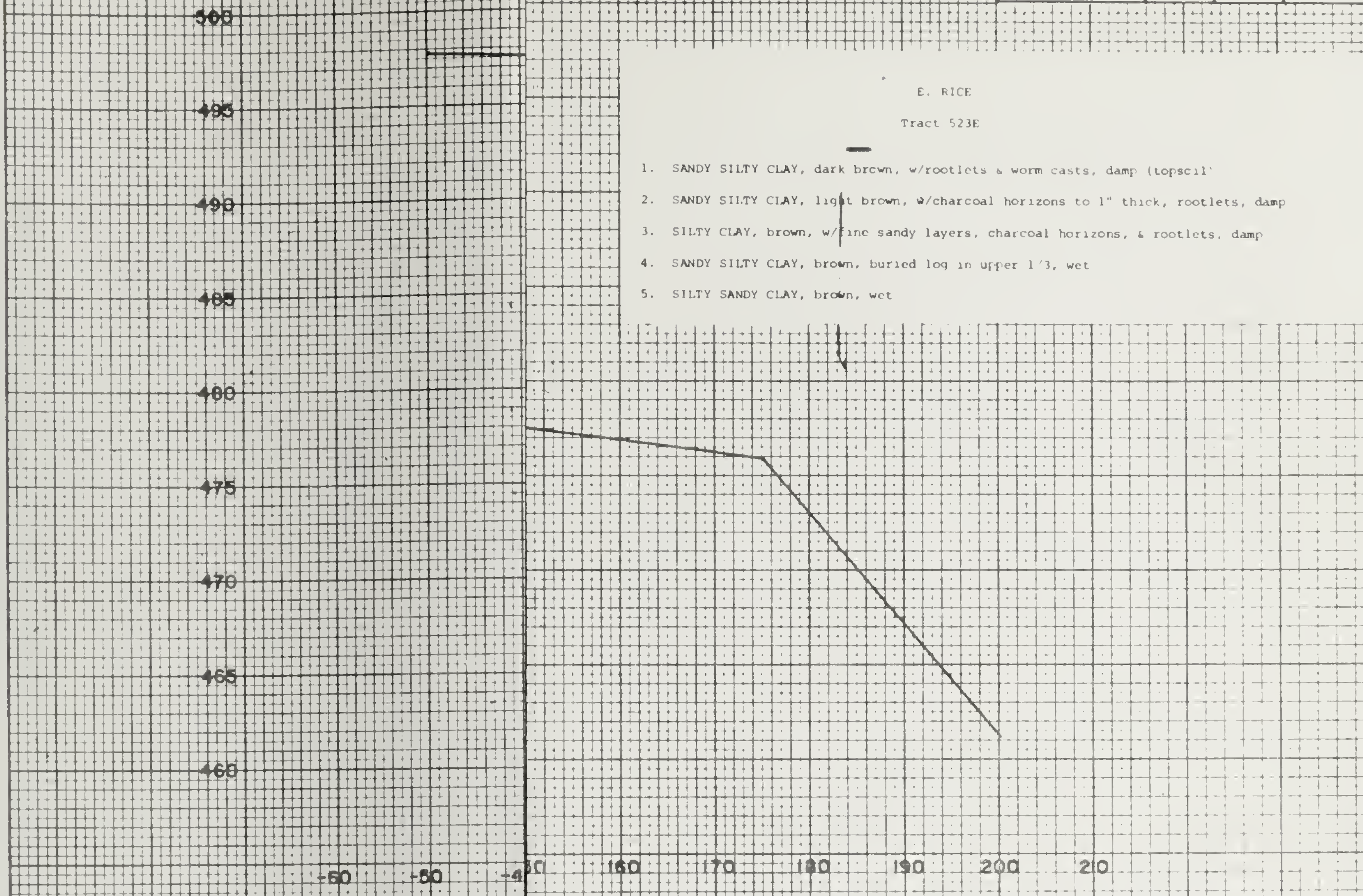
MELDAHL POOL

ETHYL RICE, TRACT NO. 523E

SOIL PROFILE
MILE 429.1

ORDXE JULY 77

COUNTY OF	FISCAL YEAR	SHEET NO	TOTAL SHEETS



FINAL SURVEY — NOTE BOOK — NO — SURVEYED — PLOTTED — TEMPLATE — AREAS — AREAS CHECKED — BY — DATE

ORIGINAL SURVEY — NOTE BOOK — NO — SURVEYED — PLOTTED — TEMPLATE — AREAS — AREAS CHECKED — BY — DATE

500
495
490
485
480
475

U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

MELDAHL POOL

ETHYL RICE, TRACT NO. 523E

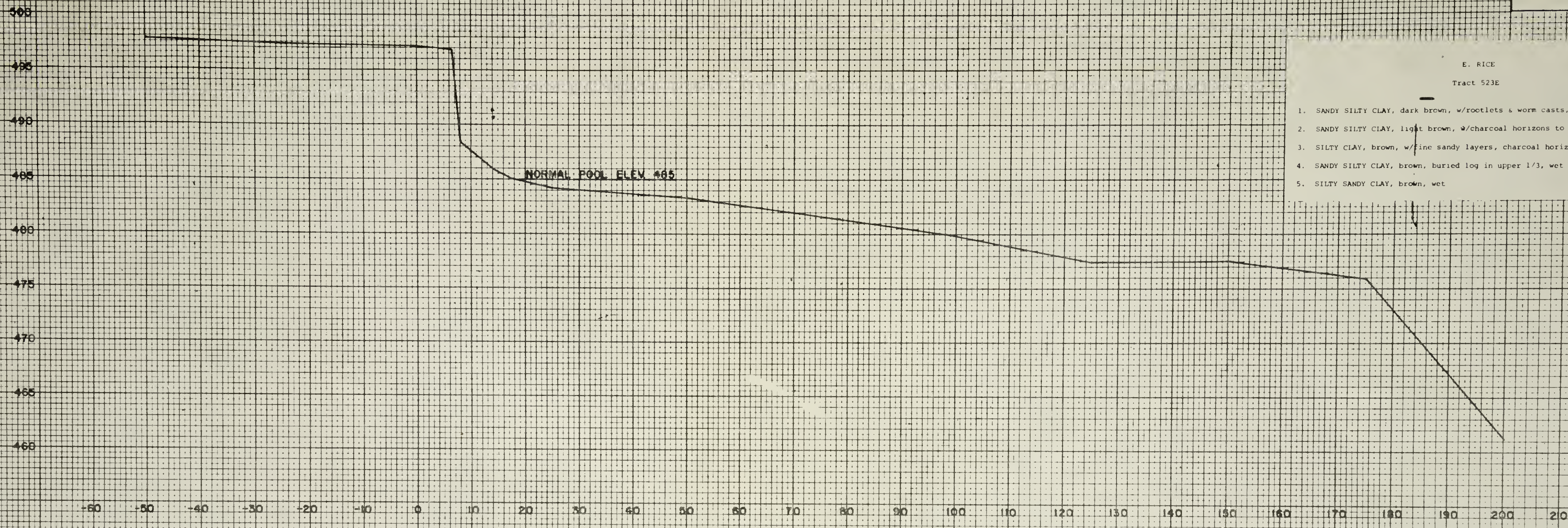
SOIL PROFILE

MILE 429.1

ORDXE JULY 77

DIETZGEN 8-17-70
FORM NO. 8

COUNTY OF	FISCAL YEAR	SHEET NO	TOTAL SHEETS

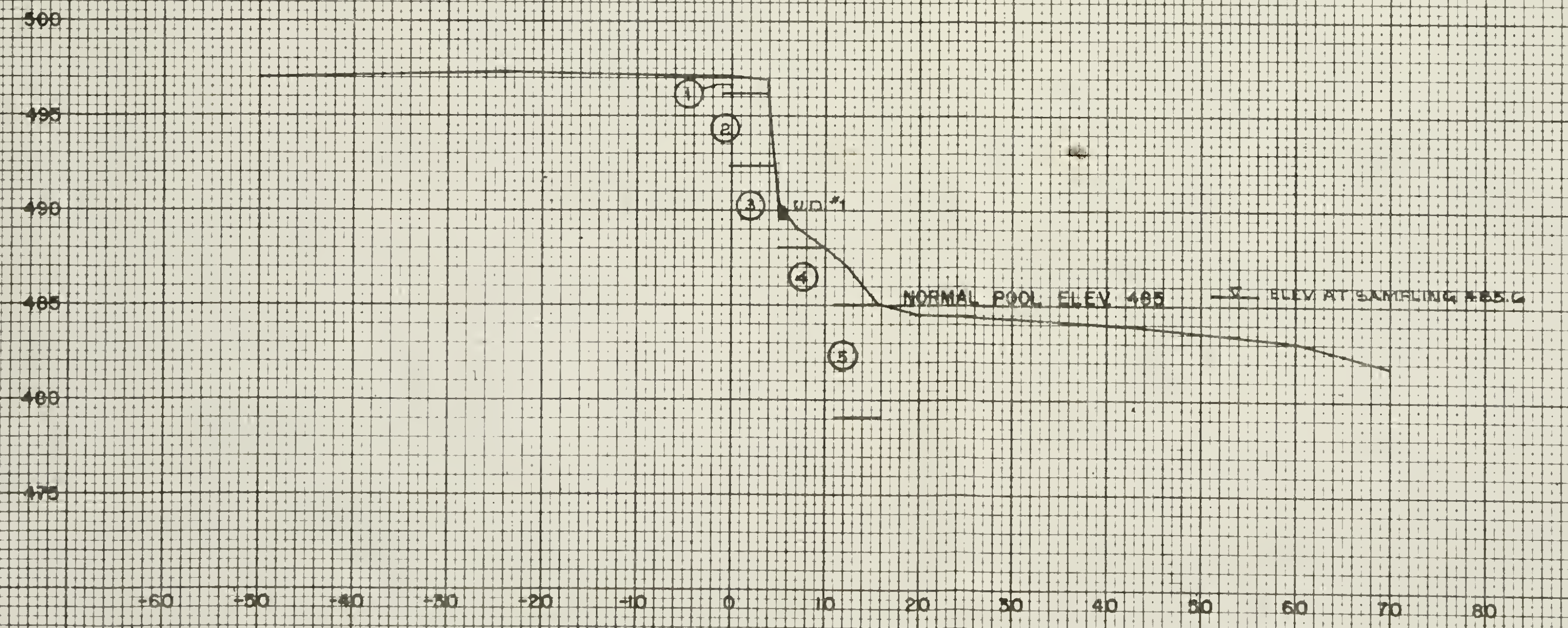


SECTION NO. 18 (TRACT NO. 523E)
1977 FIELD SECTIONS

E. RICE

Tract 523E

1. SANDY SILTY CLAY, dark brown, w/rootlets & worm casts, damp (topsoil)
2. SANDY SILTY CLAY, light brown, w/charcoal horizons to 1" thick, rootlets, damp
3. SILTY CLAY, brown, w/fine sandy layers, charcoal horizons, & rootlets, damp
4. SANDY SILTY CLAY, brown, buried log in upper 1/3, wet
5. SILTY SANDY CLAY, brown, wet



SECTION NO. 19 (TRACT NO. 523E)
1977 FIELD SECTION

U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY

MELDAHL POOL

ETHYL RICE, TRACT NO. 523E

SOIL PROFILE
MILE 429.1

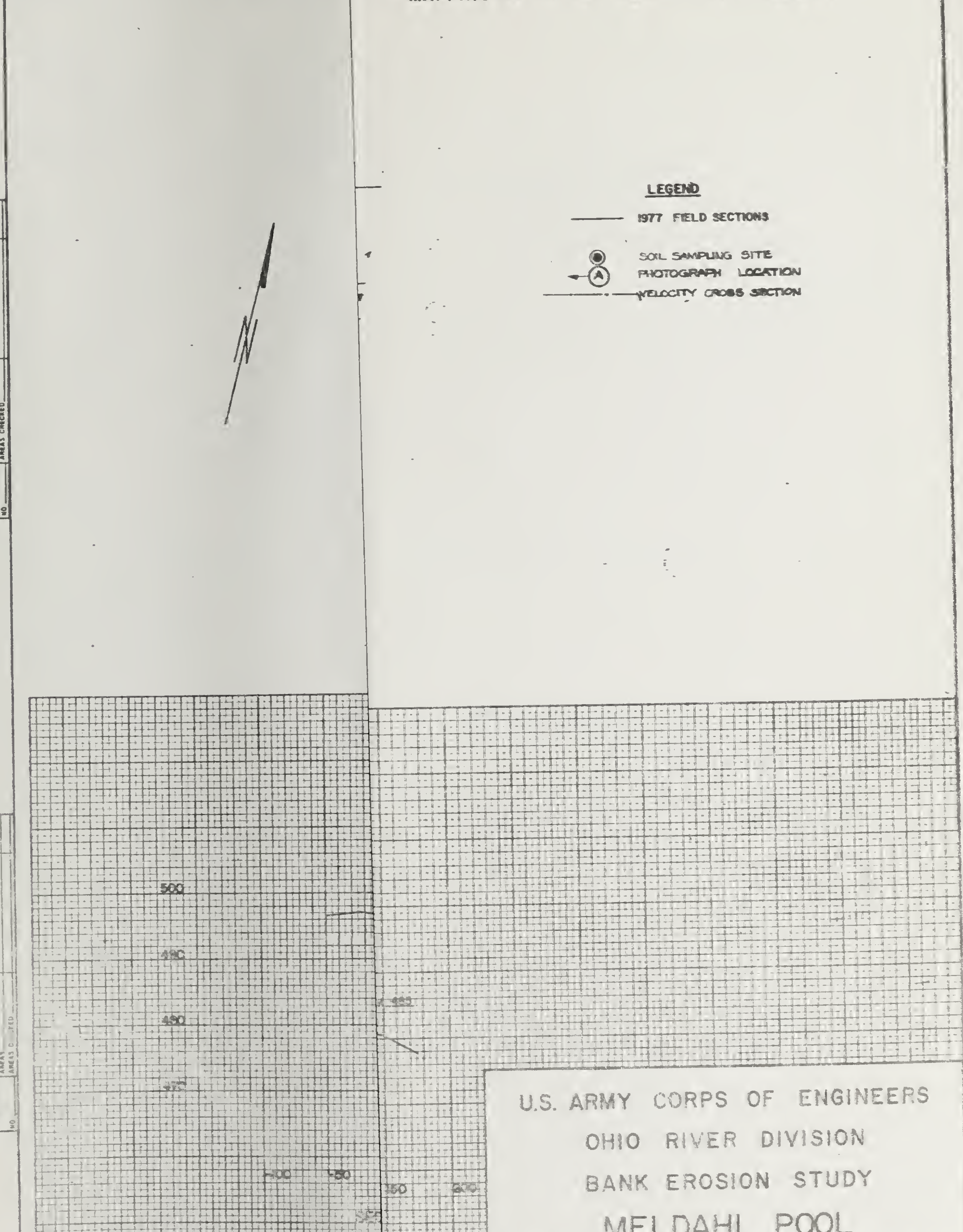
ORDXE JULY 77

DATE	BY	
		SURVEYED / PLOTTED / TEMPLATE / AREAS / AREAS CHECKED
FINAL SURVEY	NOTE BOOK	NO

DATE	BY	
		SURVEYED / PLOTTED / TEMPLATE / AREAS / AREAS CHECKED
ORIGINAL SURVEY	NOTE BOOK	NO

DIETZGEN 6-17-70
FORM NO. 6

MAPPING BASED ON 22 MAR.77 PHOTOGRAPHY



U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

MELDAHL POOL

EUGENE & ELIZABETH POSTON, TRACT NO. 527E-182

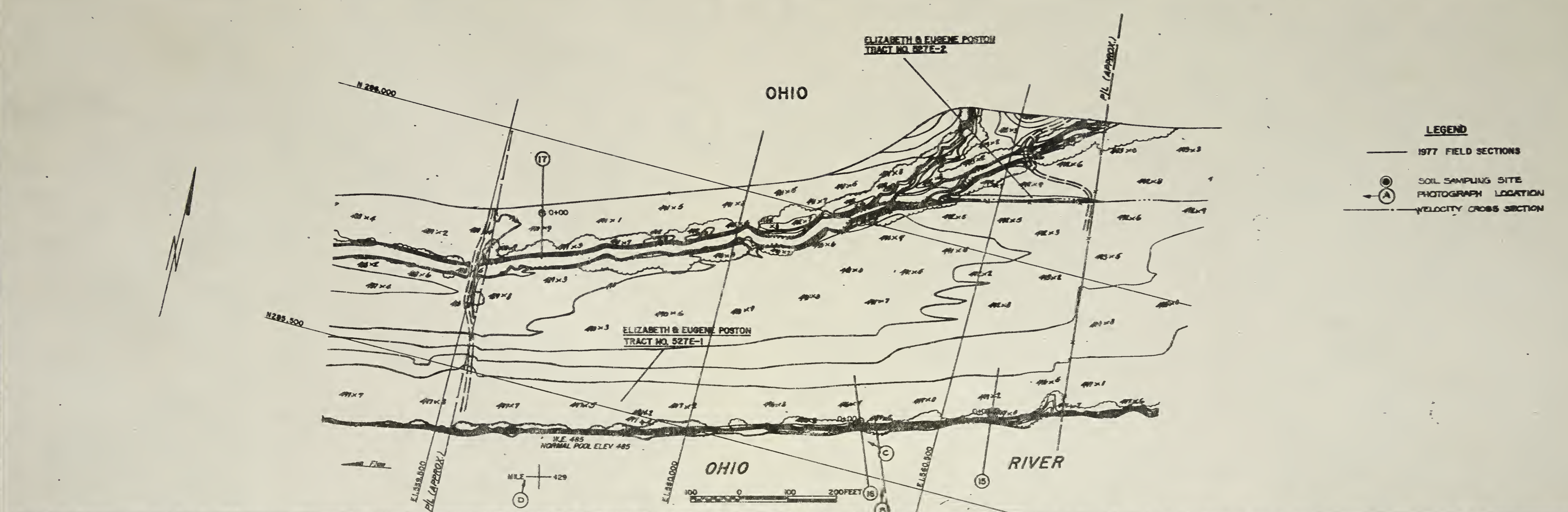
PLAN AND SECTIONS

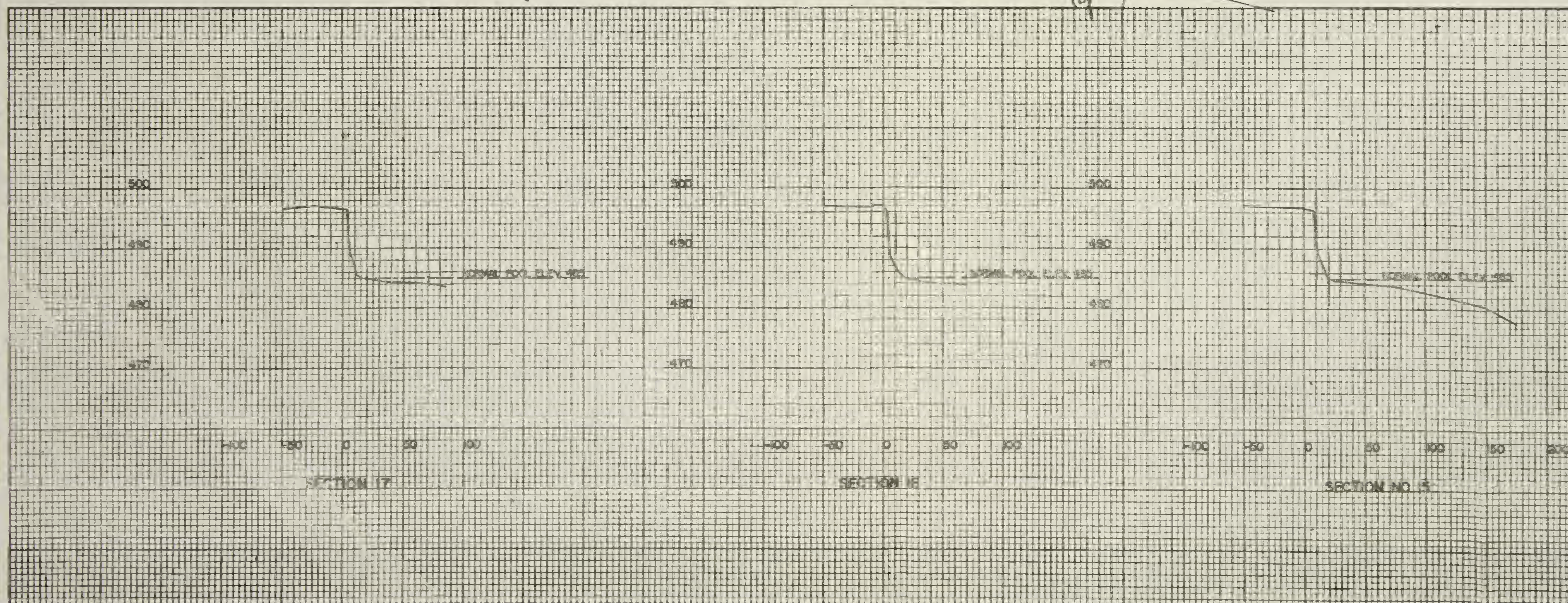
MILE 428.3

ORDXE JULY 77

PLATE 30 SHEET 1 OF 2

MAPPING BASED ON 22 MAR.77 PHOTOGRAPHY





U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY

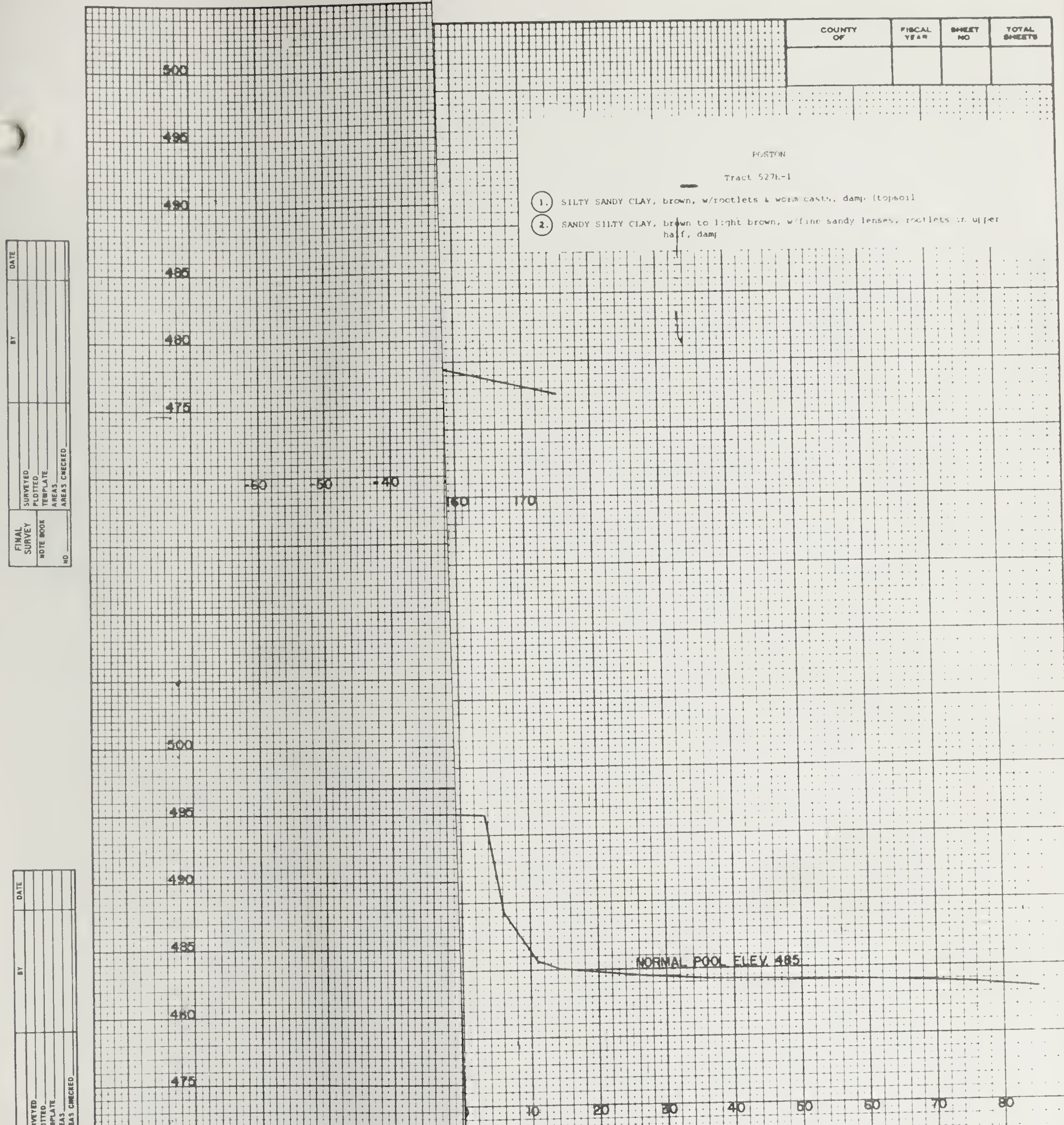
MELDAHL POOL

EUGENE & ELIZABETH POSTON, TRACT NO. 527E-1&2
PLAN AND SECTIONS
MILE 428.3

ORDXE JULY 77

PLATE 30

SHEET 1 OF 2



U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

MELDAHL POOL

EUGENE & ELIZABETH POSTON, TRACT NO. 527E-1&2

SOIL & VEGETATION PROFILE

MILE 428.3

ORDXE JULY 77

DIETZGEN 8-17-70
FORM NO. 8

PLATE 30

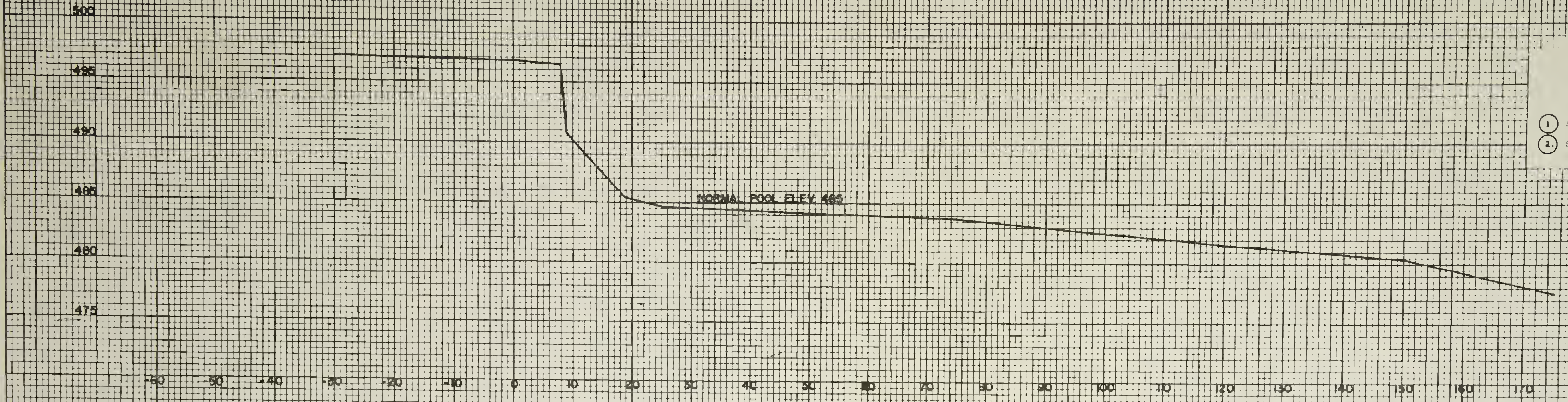
SHEET 2 OF 2

COUNTY OF	FISCAL YEAR	SHEET NO	TOTAL SHEETS

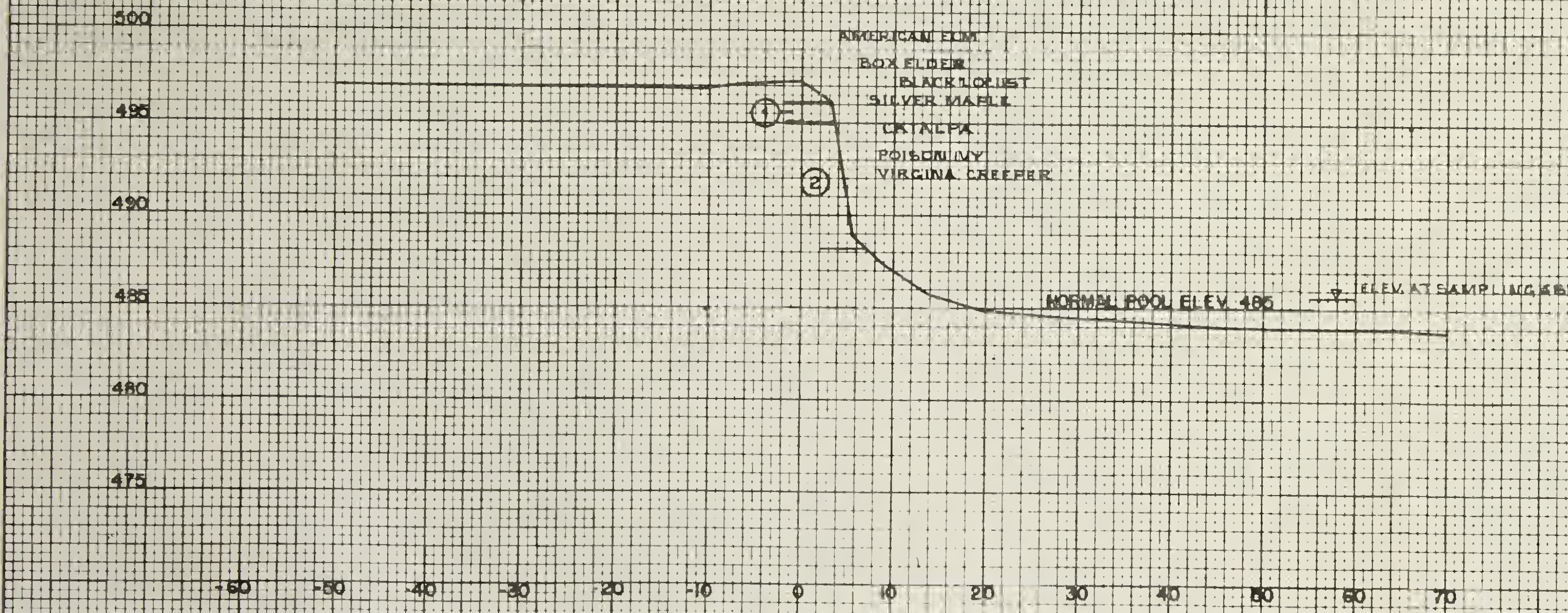
POSTON

Tract 527E-1

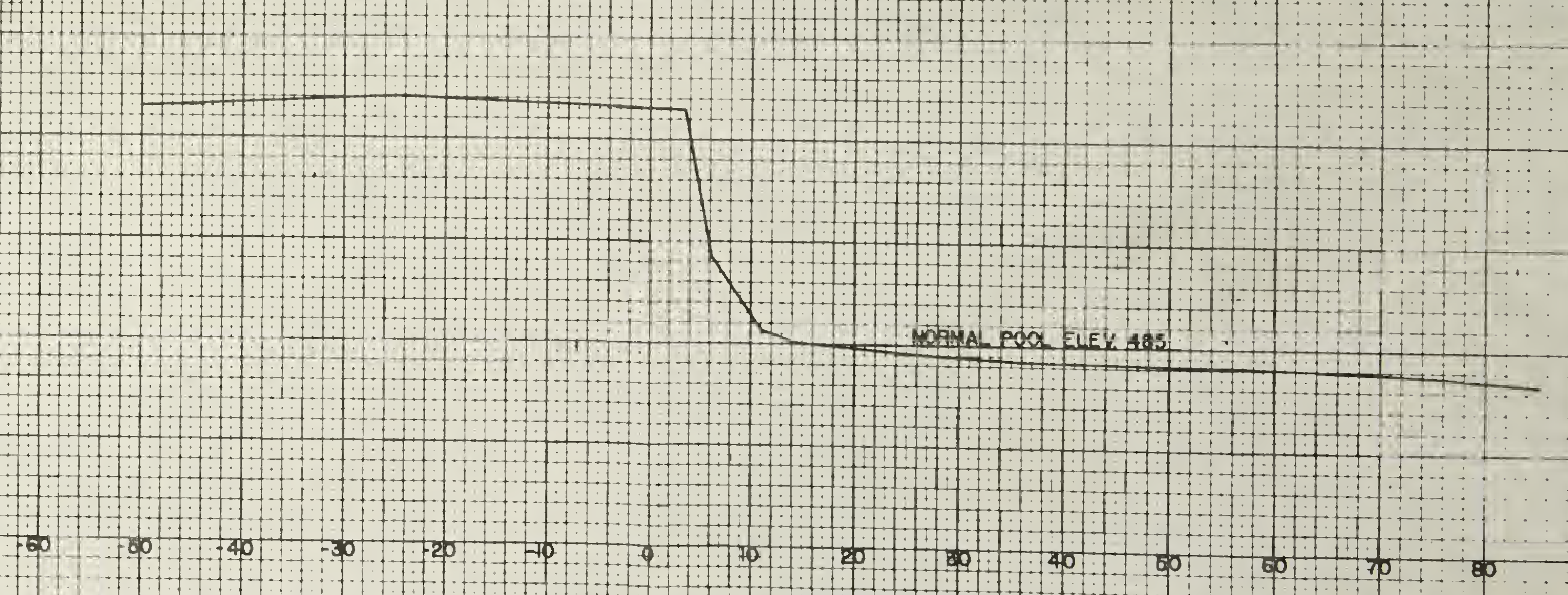
1. SILTY SANDY CLAY, brown, w/rootlets & worm casts, damp (topsoil
2. SANDY SILTY CLAY, brown to light brown, w/fine sandy lenses, rootlets in upper half, damp



SECTION NO 15 (TRACT NO. 527E-1)
1977 FIELD SECTIONS



SECTION NO 16 (TRACT NO 527E-1)
1977 FIELD SECTIONS



SECTION NO 17 (TRACT NO 527E-2)
1977 FIELD SECTIONS

U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY

MELDAHL POOL

EUGENE & ELIZABETH POSTON, TRACT NO. 527E-1&2
SOIL & VEGETATION PROFILE
MILE 428.3

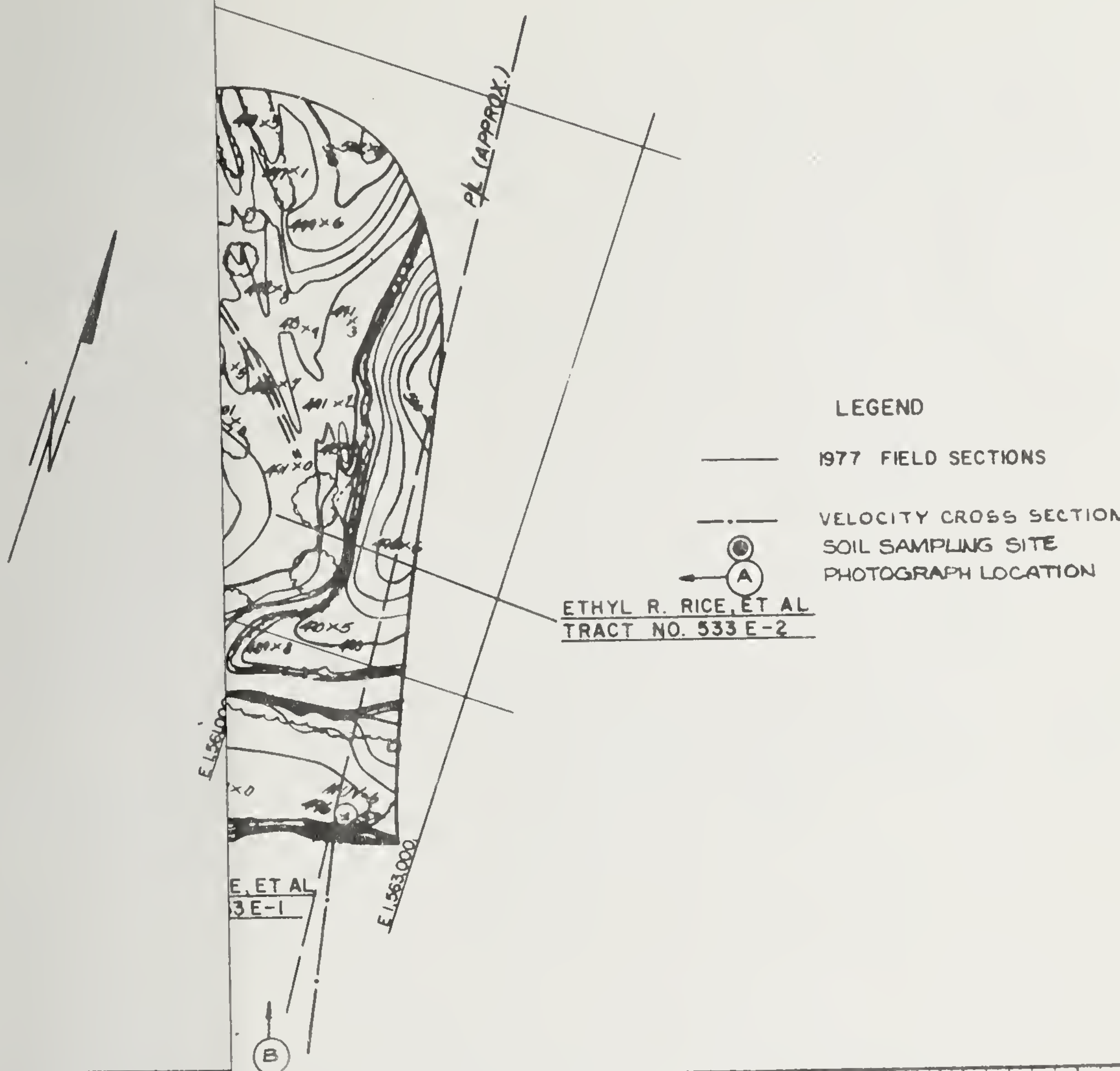
ORDXE JULY 77

DIETZGEN 8-17-70
FORM NO. 8

PLATE 30

SHEET 2 OF 2

MAPPING BASED ON 22 MAR. 77 PHOTOGRAPHY



FINAL SURVEY: NOTE BOOK, NO; SURVEYED, PLOTTED, TEMPLATE, AREAS, AREAS CHECKED; BY; DATE

ORIGINAL SURVEY: NOTE BOOK, NO; SURVEYED, PLOTTED, TEMPLATE, AREAS, AREAS CHECKED; BY; DATE

U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

MELDAHL POOL

CHARLES & JEAN RICE, TRACT NO. 533E-1&2

PLAN AND SECTION

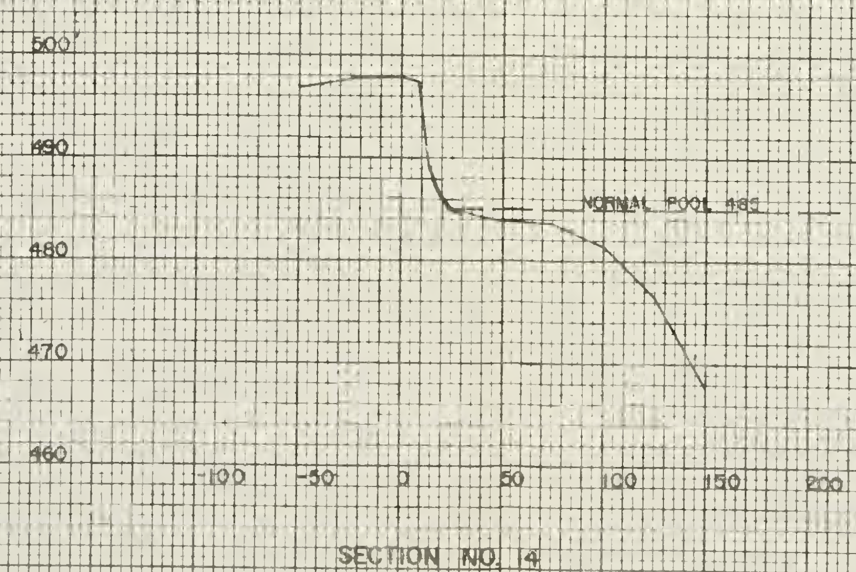
MILE 428.9

ORDXE JULY 77

PLATE 31

SHEET 1 OF 2

MAPPING BASED ON 22 MAR. 77 PHOTOGRAPHY



U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY

MELDAHL POOL

CHARLES & JEAN RICE, TRACT NO. 533E-1&2

PLAN AND SECTION

MILE 428.9

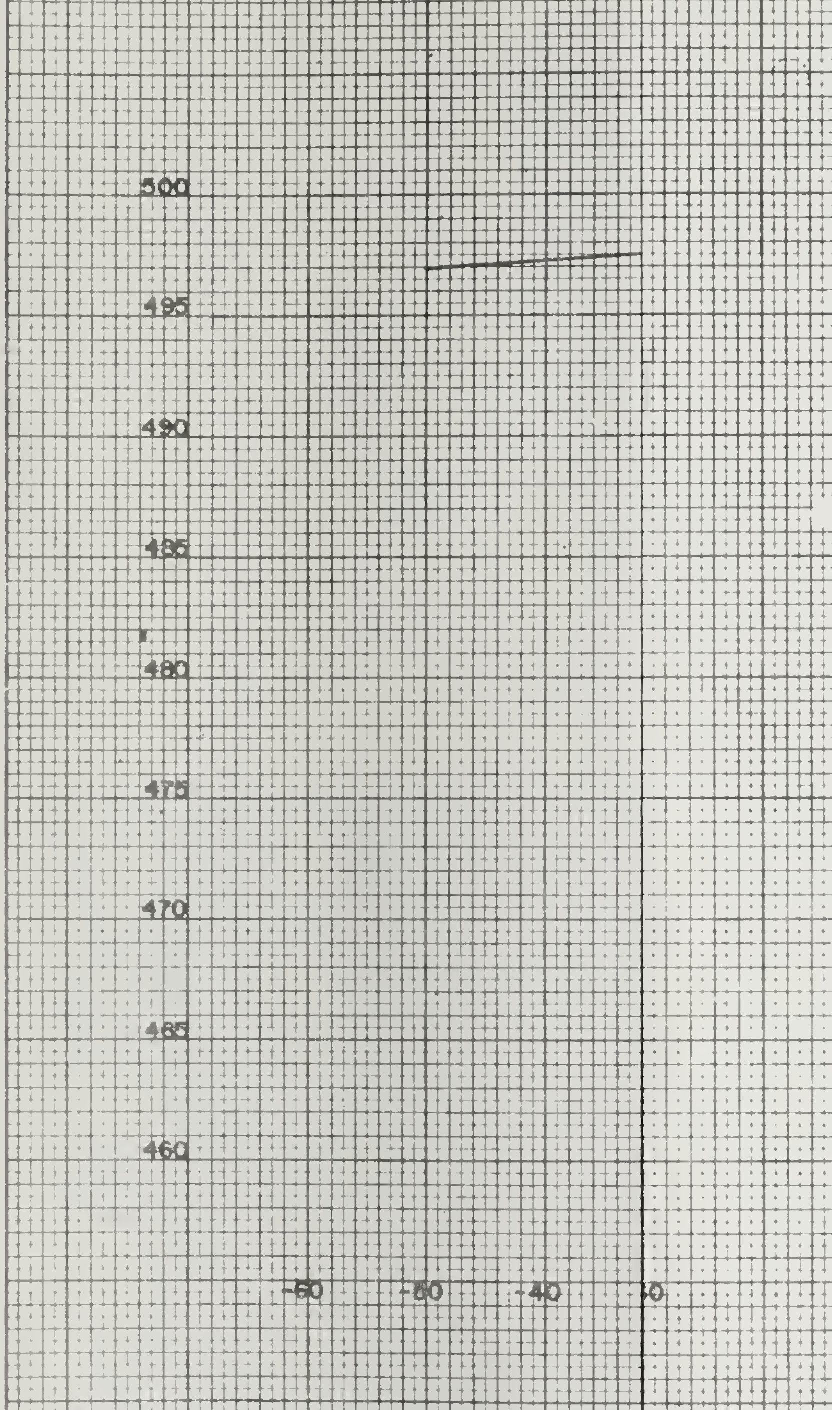
ORDXE JULY 77

COUNTY OF	FISCAL YEAR	SHEET NO	TOTAL SHEETS

C. & J. RICE

Tract 533E-1 & 2

1. SILTY SANDY CLAY, brown to dark brown, w/lenses of fine sand to 3", rootlets, worm casts, damp
2. SANDY SILTY CLAY, brown, w/fine sand layers, damp
3. SANDY SILTY CLAY, brown, wet
4. SANDY SILTY CLAY, brown, lenses of fine sand & layers of silty clay & organic debris, wet



FINAL SURVEY		BY	DATE
NOTE BOOK	SURVEYED		
NO	PLOTTED		
	TEMPLATE		
	AREAS		
	AREAS CHECKED		

ORIGINAL SURVEY		BY	DATE
NOTE BOOK	SURVEYED		
NO	PLOTTED		
	TEMPLATE		
	AREAS		
	AREAS CHECKED		

U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

MELDAHL POOL

CHARLES & JEAN RICE, TRACT NO. 533E-1&2

SOIL PROFILE

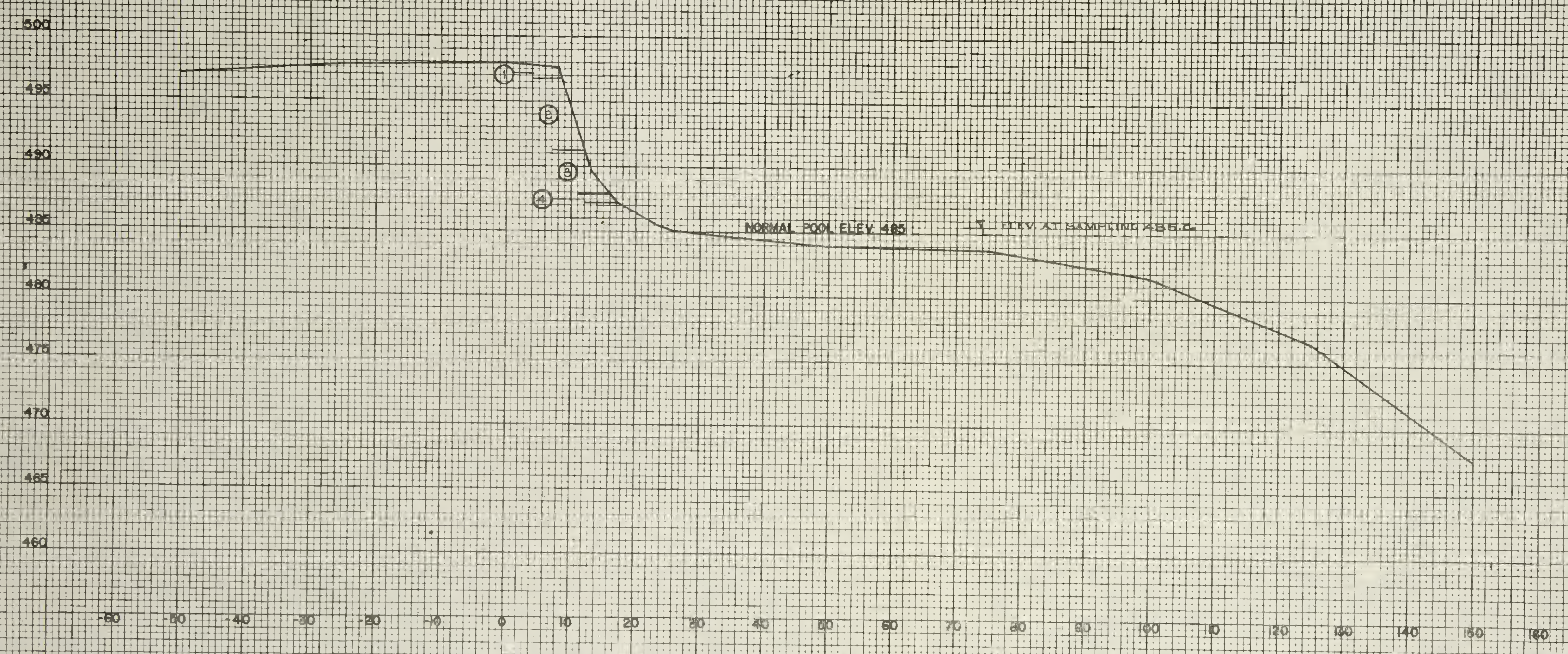
MILE 428.9

ORDXE JULY 77

C. & J. RICE

Tract 533E-1 & 2

1. SILTY SANDY CLAY, brown to dark brown, w/lenses of fine sand to 3", rootlets, worm casts, damp
2. SANDY SILTY CLAY, brown, w/fine sand layers, damp
3. SANDY SILTY CLAY, brown, wet
4. SANDY SILTY CLAY, brown, lenses of fine sand & layers of silty clay & organic debris, wet



SECTION NO. 14 (TRACT NO. 533E-1)
1977 FIELD SECTIONS

COUNTY OF	FISCAL YEAR	SHEET NO.	TOTAL SHEETS

FINAL SURVEY	
SURVEYED	
PLOTTED	
TEMPLATE	
AREAS	
AREAS CHECKED	
NOTE BOOK	
NO.	
BY	
DATE	

ORIGINAL SURVEY	
SURVEYED	
PLOTTED	
TEMPLATE	
AREAS	
AREAS CHECKED	
NOTE BOOK	
NO.	
BY	
DATE	

U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY

MELDAHL POOL

CHARLES & JEAN RICE, TRACT NO. 533E-1&2

SOIL PROFILE
MILE 428.9

ORDXE JULY 77

MAPPING BASED ON 22 MAR.77 PHOTOGRAPHY

LEGEND

1977 FIELD SECTIONS

WAVE MEASUREMENT SITE

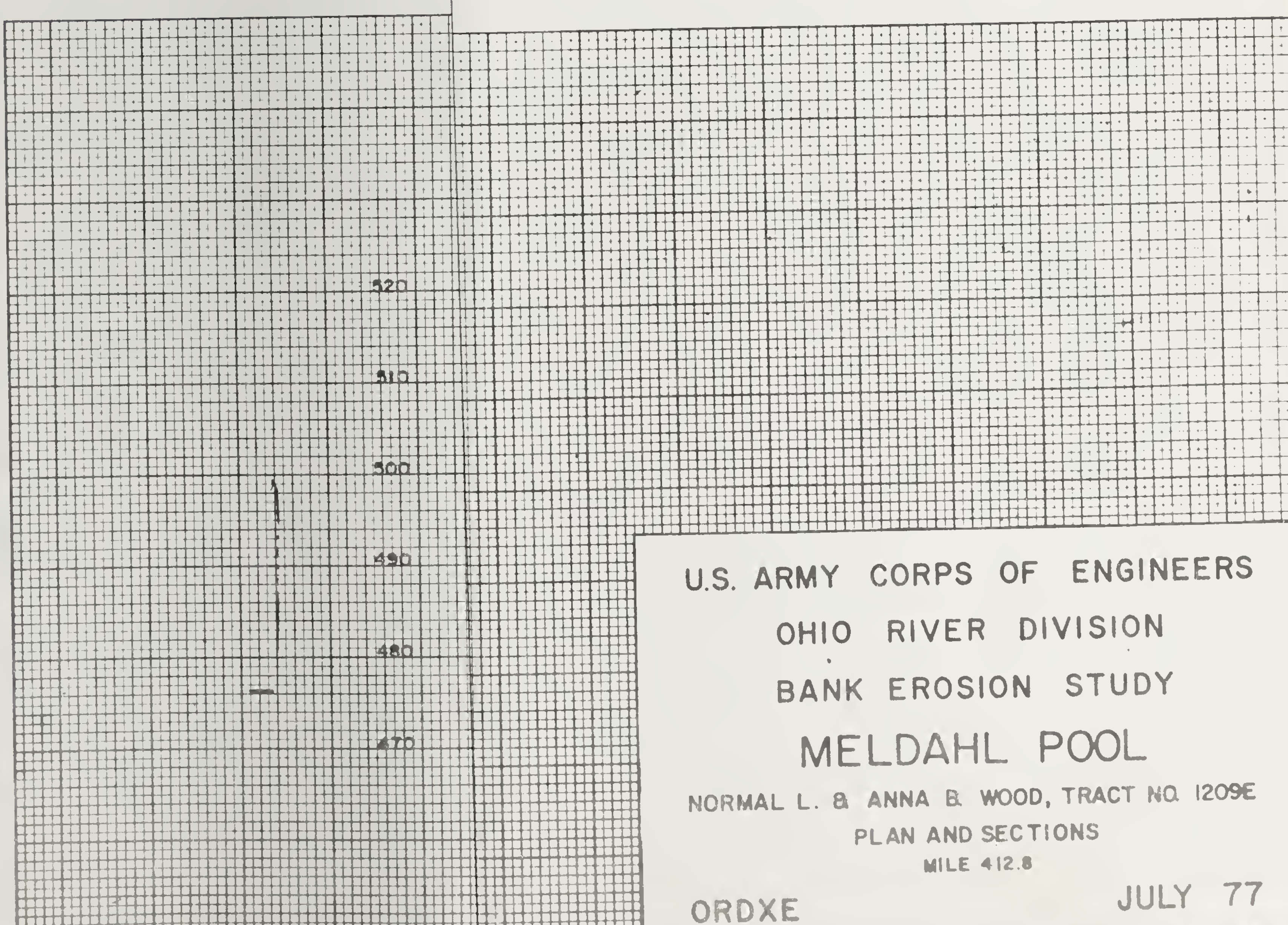
VELOCITY CROSS SECTION

SOIL SAMPLING

PHOTOGRAPH LOCATION

FINAL SURVEY		BY	DATE
NOTE BOOK	SURVEYED		
	PLOTTED		
	TEMPLATE		
	AREAS		
NO	AREAS CHECKED		

ORIGINAL SURVEY		BY	DATE
NOTE BOOK	SURVEYED		
	PLOTTED		
	TEMPLATE		
	AREAS		
NO	AREAS CHECKED		



U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

MELDAHL POOL

NORMAL L. & ANNA B. WOOD, TRACT NO. 1209E

PLAN AND SECTIONS

MILE 412.8

ORDXE

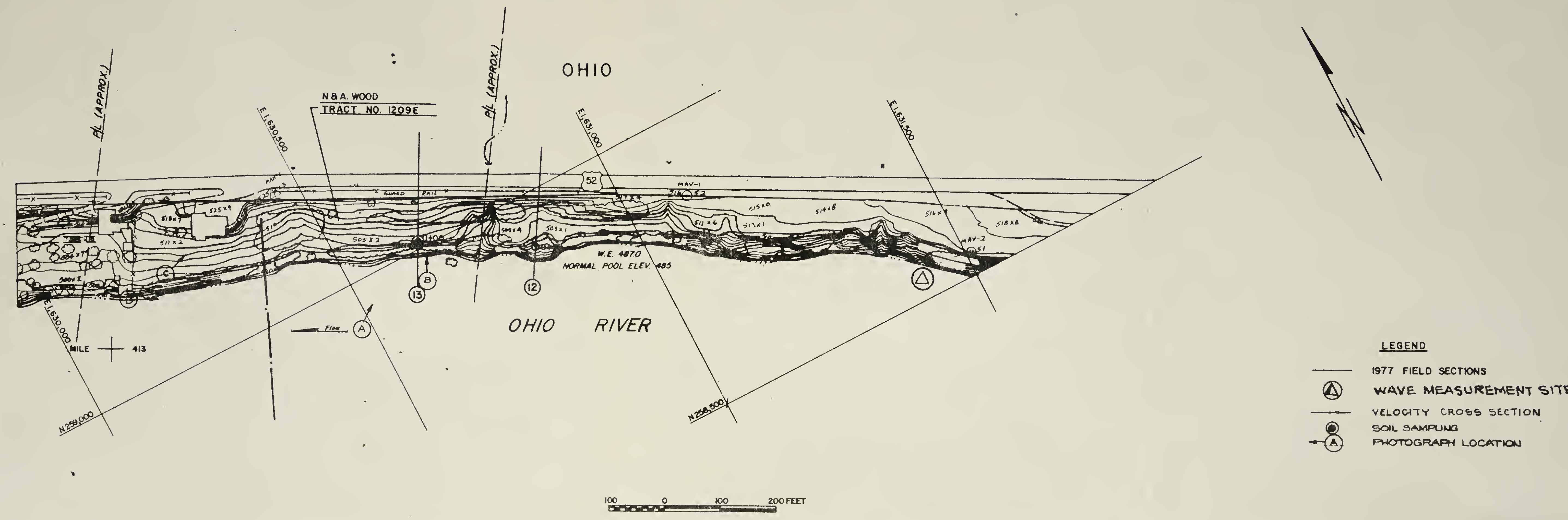
JULY 77

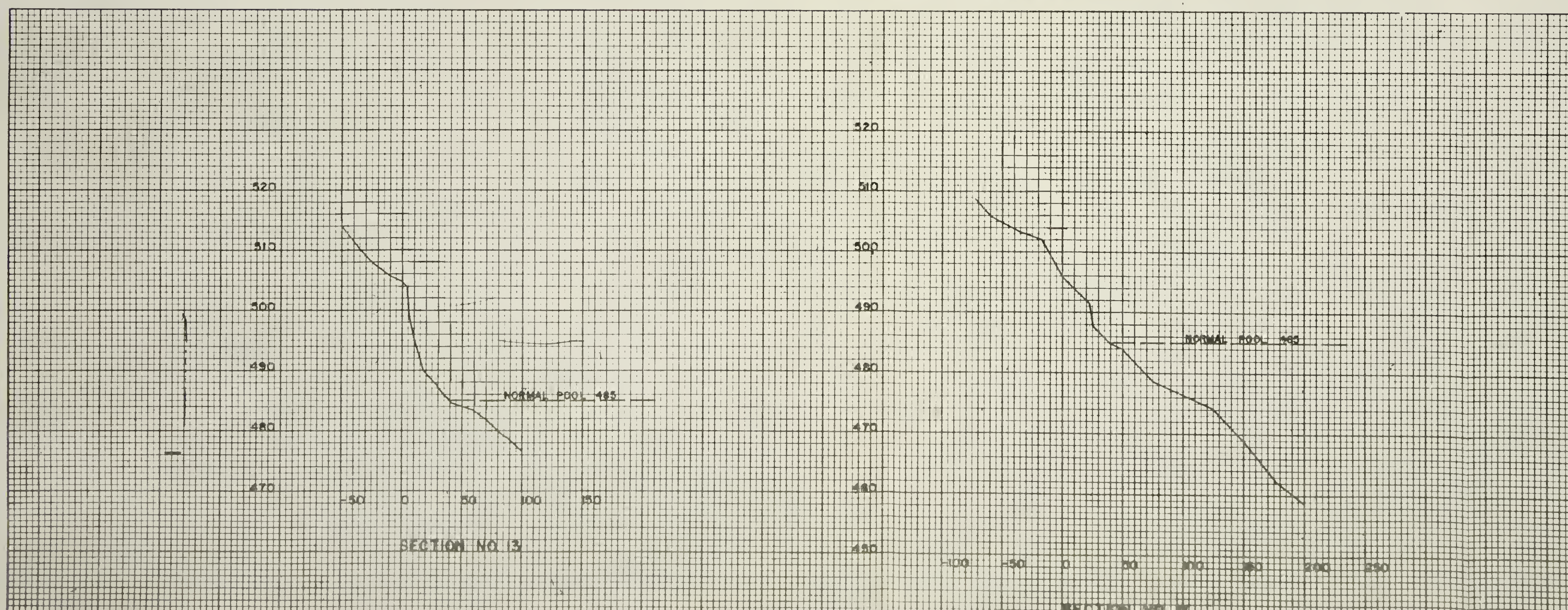
PLATE 32

SHEET 1 OF 2

FORM NO. 8

MAPPING BASED ON 22 MAR.77 PHOTOGRAPHY





U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY

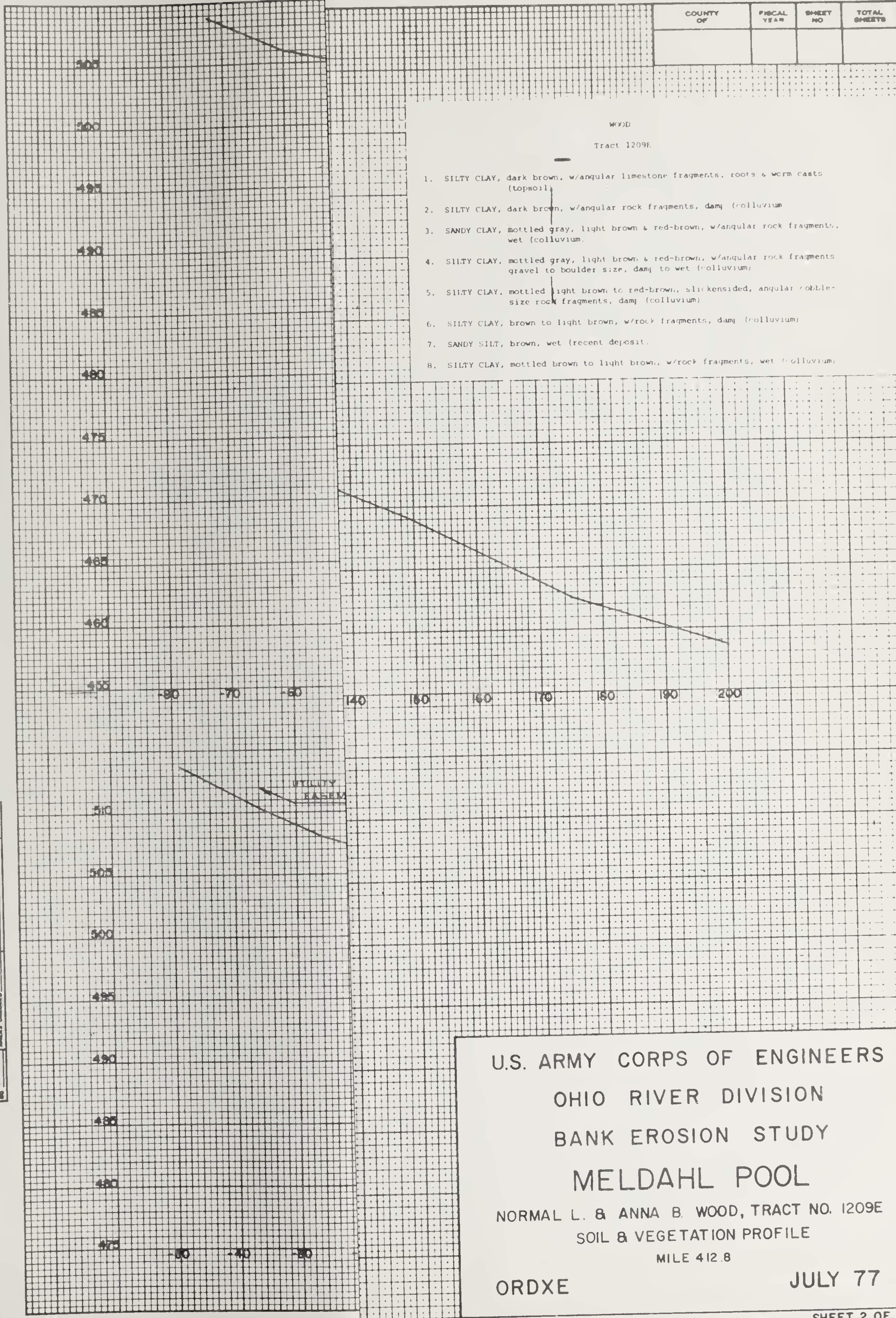
MELDAHL POOL

NORMAL L. & ANNA B. WOOD, TRACT NO. 1209E
PLAN AND SECTIONS
MILE 412.8

ORDXE JULY 77

PLATE 32

SHEET 1 OF 2



WOOD

Tract 1209E

1. SILTY CLAY, dark brown, w/angular limestone fragments, roots & worm casts (topsoil)
2. SILTY CLAY, dark brown, w/angular rock fragments, damp (colluvium
3. SANDY CLAY, mottled gray, light brown & red-brown, w/angular rock fragments, wet (colluvium
4. SILTY CLAY, mottled gray, light brown & red-brown, w/angular rock fragments gravel to boulder size, damp to wet (colluvium)
5. SILTY CLAY, mottled light brown to red-brown, slickensided, angular cobble-size rock fragments, damp (colluvium)
6. SILTY CLAY, brown to light brown, w/rock fragments, damp (colluvium)
7. SANDY SILT, brown, wet (recent deposit
8. SILTY CLAY, mottled brown to light brown, w/rock fragments, wet (colluvium)

U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

MELDAHL POOL

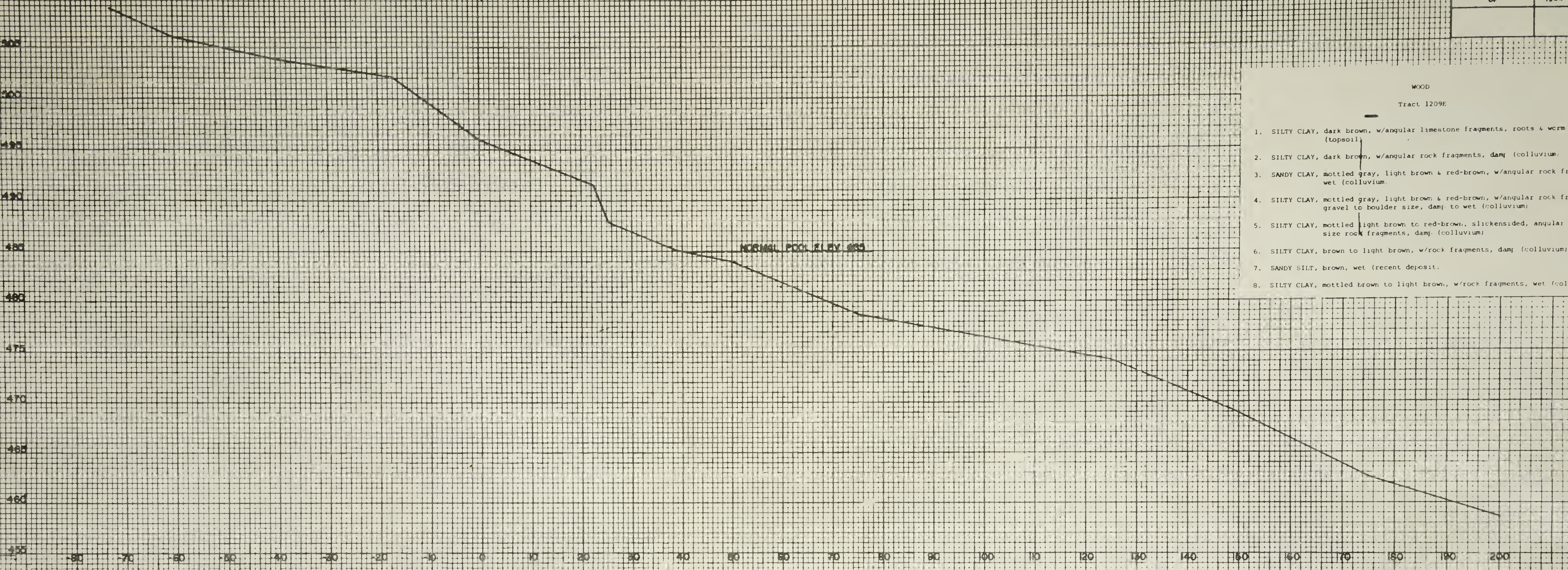
NORMAL L. & ANNA B. WOOD, TRACT NO. 1209E

SOIL & VEGETATION PROFILE

MILE 412.8

ORDXE JULY 77

SHEET 2 OF 2

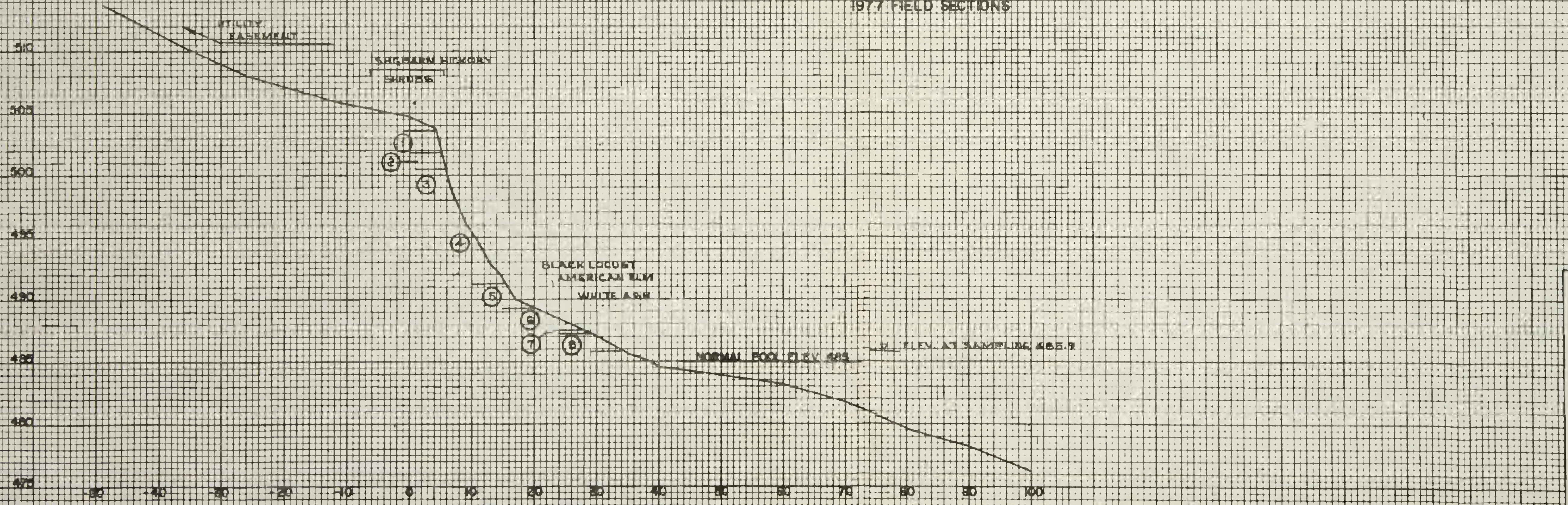


SECTION NO. 2 (TRACT NO. 1209E)
1977 FIELD SECTIONS

WOOD

Tract 1209E

1. SILTY CLAY, dark brown, w/angular limestone fragments, roots & worm casts (topsoil)
2. SILTY CLAY, dark brown, w/angular rock fragments, damp (colluvium)
3. SANDY CLAY, mottled gray, light brown & red-brown, w/angular rock fragments, wet (colluvium)
4. SILTY CLAY, mottled gray, light brown & red-brown, w/angular rock fragments gravel to boulder size, damp to wet (colluvium)
5. SILTY CLAY, mottled light brown to red-brown, slickensided, angular cobble-size rock fragments, damp (colluvium)
6. SILTY CLAY, brown to light brown, w/rock fragments, damp (colluvium)
7. SANDY SILT, brown, wet (recent deposit)
8. SILTY CLAY, mottled brown to light brown, w/rock fragments, wet (colluvium)



SECTION NO. 1 (TRACT NO. 1209E)
1977 FIELD SECTIONS

COUNTY OF	FISCAL YEAR	SHEET NO	TOTAL SHEETS

U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY

MELDAHL POOL

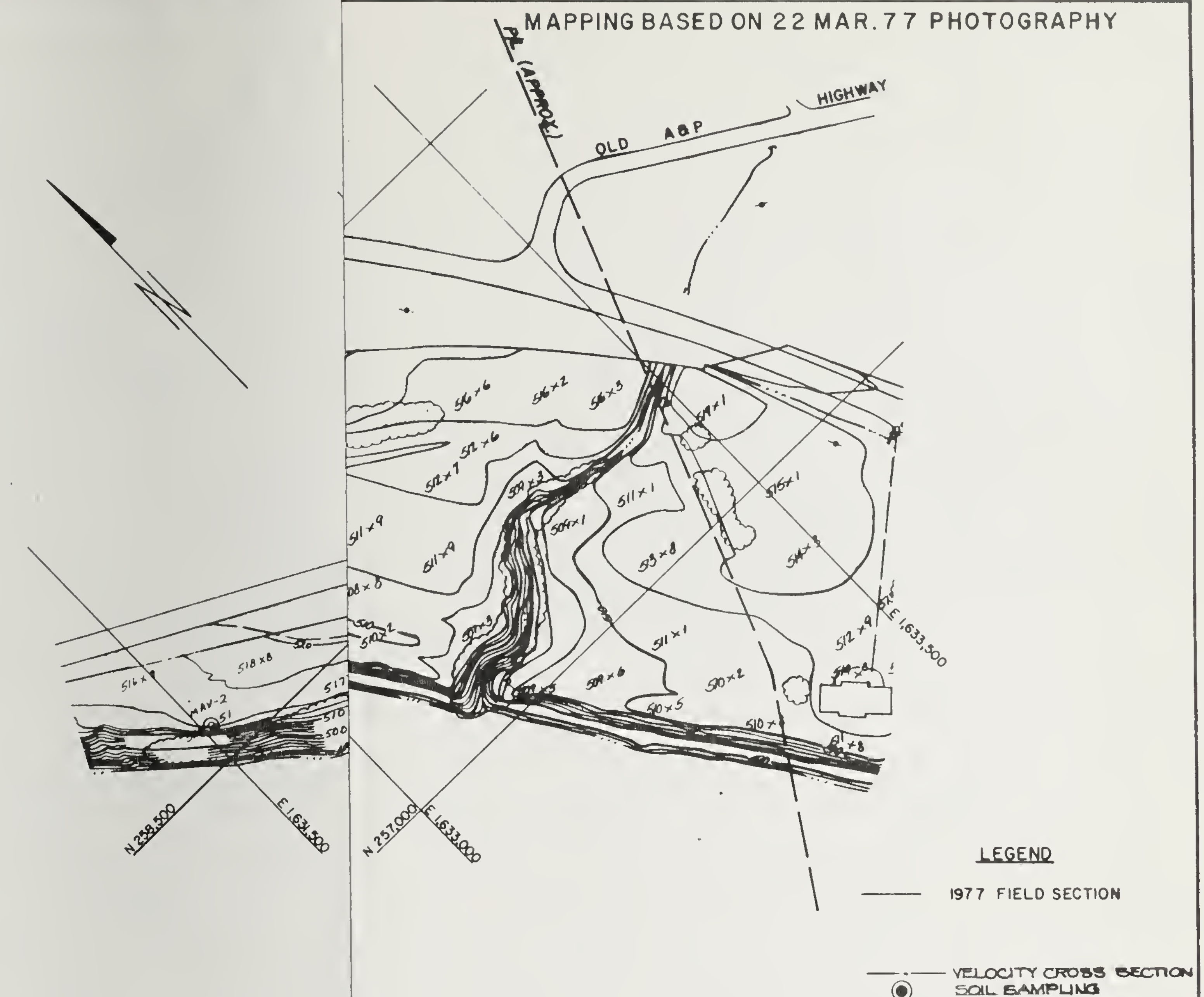
NORMAL L. & ANNA B. WOOD, TRACT NO. 1209E
SOIL & VEGETATION PROFILE
MILE 412.8

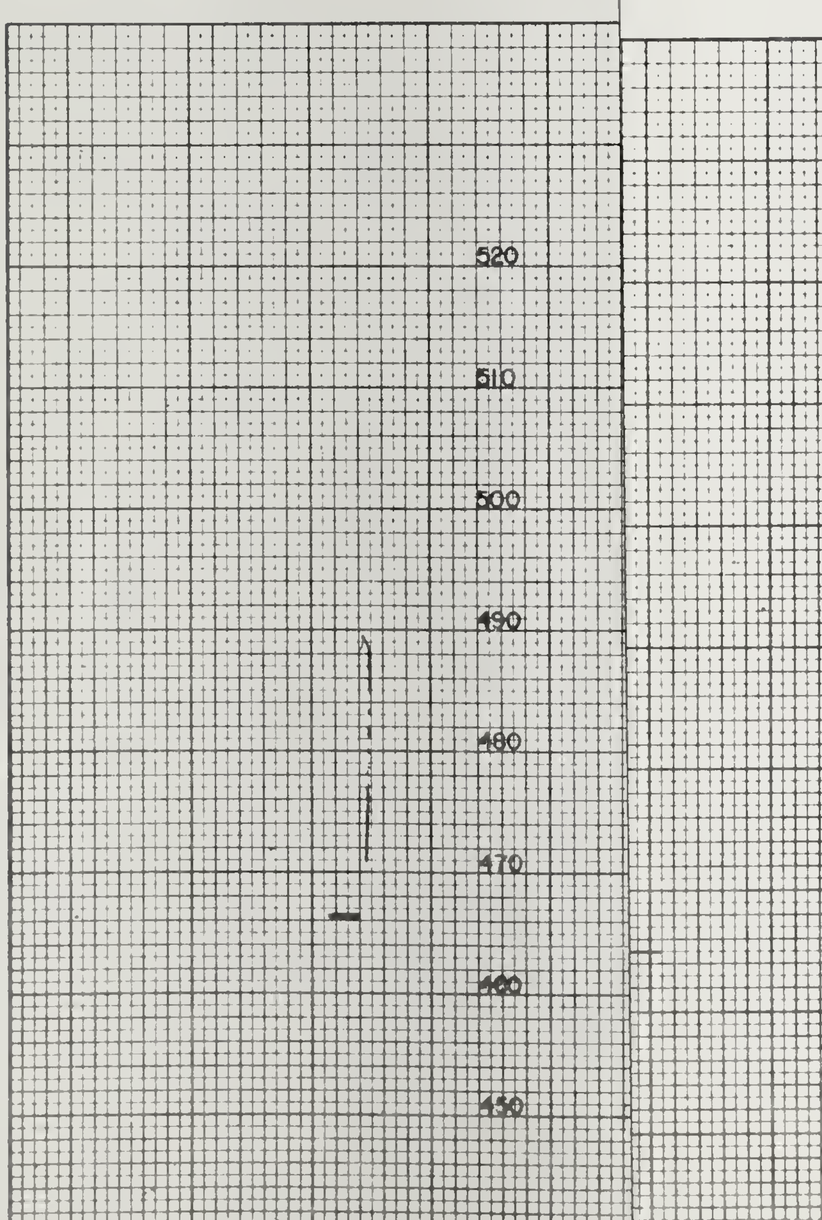
ORDXE JULY 77

PLATE 32

SHEET 2 OF 2

DIETZGEN 8-17-70
FORM NO. 6





FINAL SURVEY | NOTE BOOK | NO | SURVEYED | PLOTTED | TEMPLATE | AREAS | AREAS CHECKED | BY | DATE

ORIGINAL SURVEY | NOTE BOOK | NO | SURVEYED | PLOTTED | TEMPLATE | AREAS | AREAS CHECKED | BY | DATE

U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

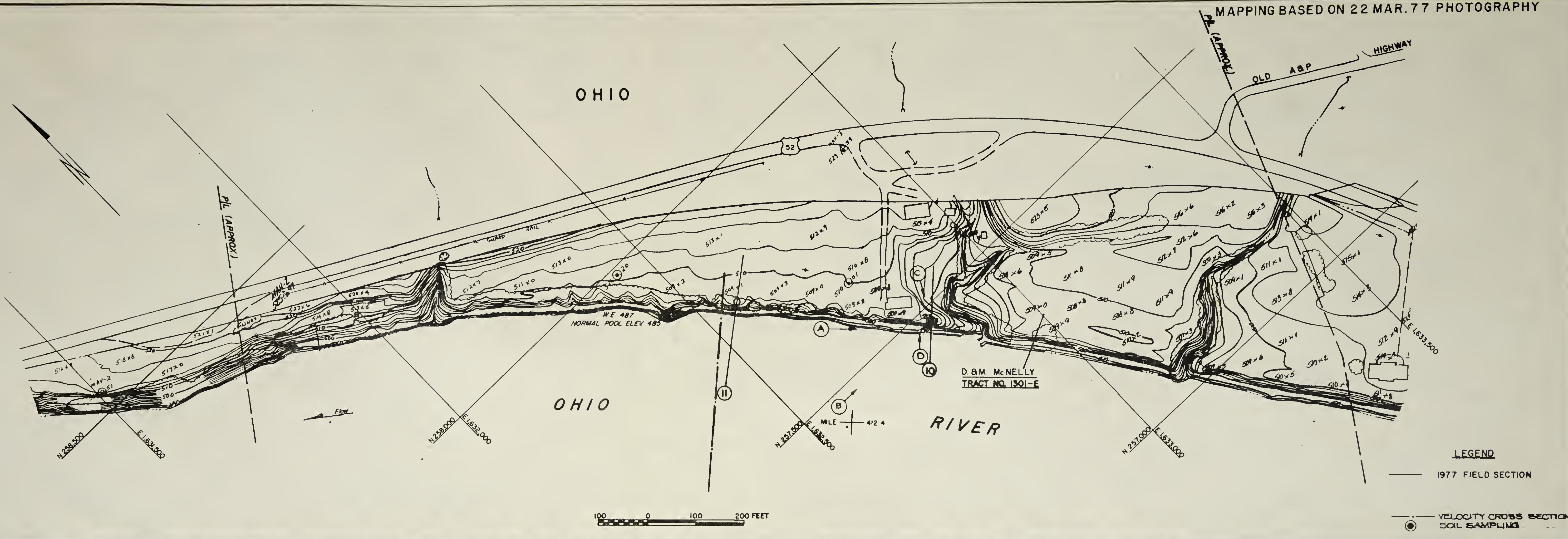
MELDAHL POOL

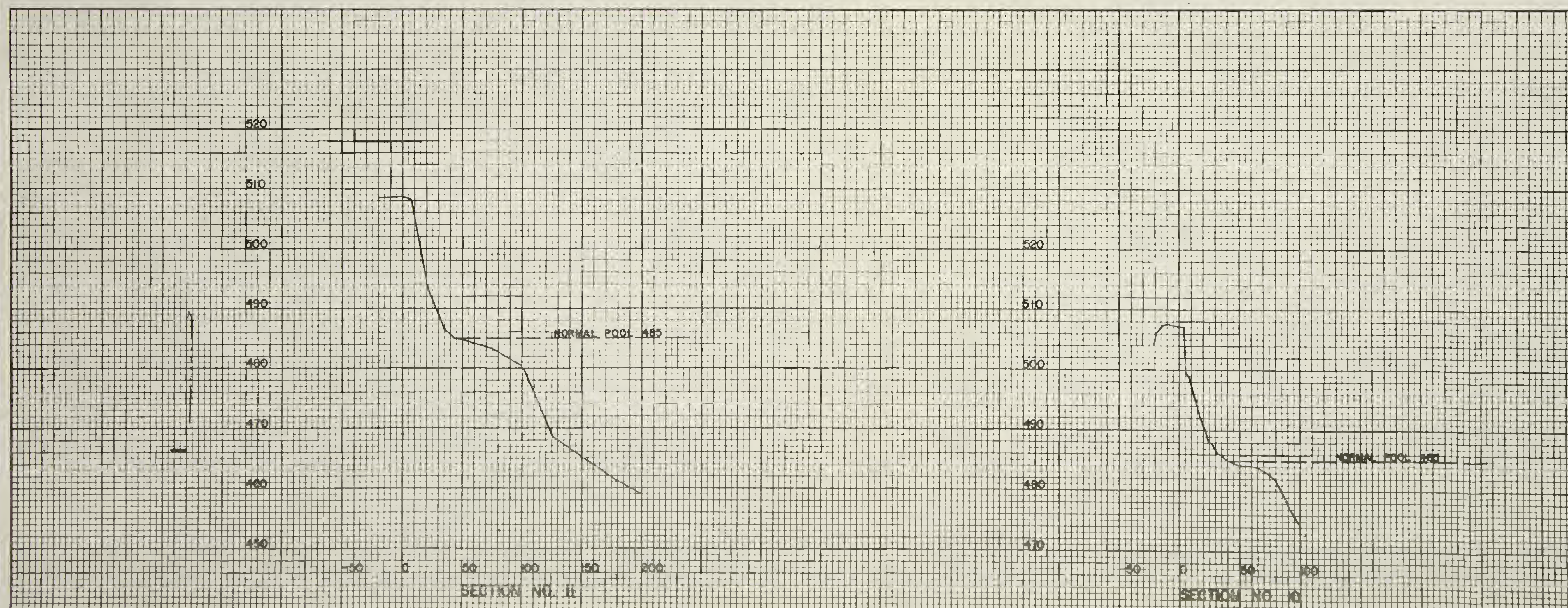
DONALD. R & MARY McNELLY, TRACT NO 1301E

PLAN AND SECTIONS

MILE 412.6

ORDXE JULY 77





U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY

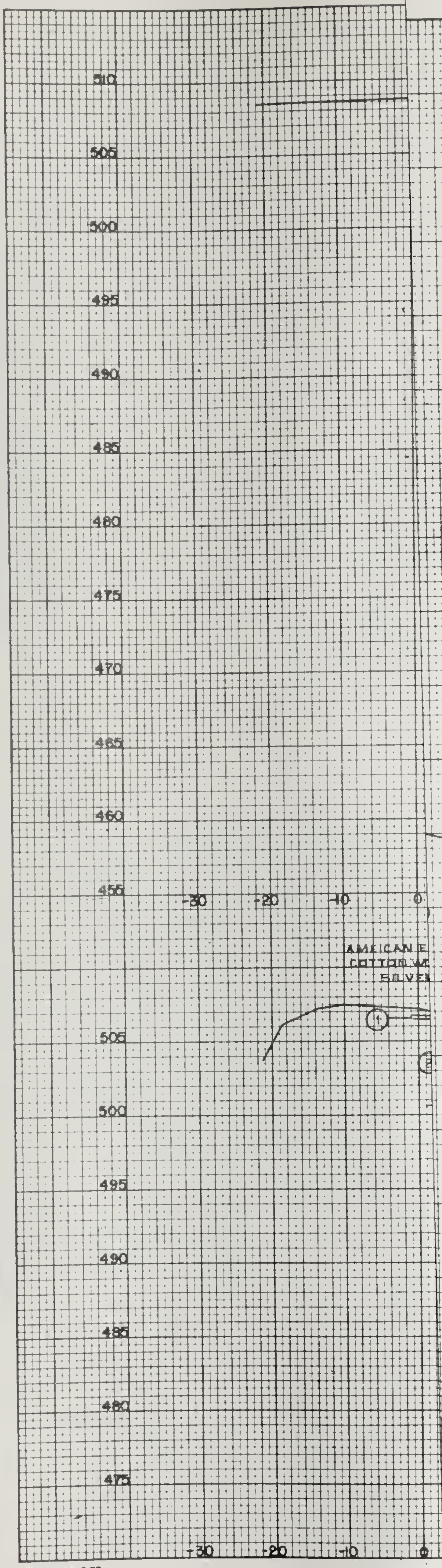
MELDAHL POOL

DONALD R & MARY McNELLY, TRACT NO. 1301E
PLAN AND SECTIONS
MILE 412.6

ORDXE JULY 77

PLATE 33

SHEET 1 OF 2



COUNTY OF	FISCAL YEAR	SHEET NO	TOTAL SHEETS

McNELLY

Tract 1301E

1. SILTY CLAY, light brown, w/rootlets & worm casts, dry (topsoil)
2. SILTY SANDY CLAY, brown, w/rootlets & worm casts, damp
3. SANDY SILTY CLAY, brown, w/fine sandy layers, damp to moist
4. SANDY SILTY CLAY, mottled brown to gray, w wood fragments, wet to damp
5. SILTY SANDY CLAY, light brown to gray, w layers of fine silty sand ranging from 13" thick in upper ½ to 2" in bottom 1/2, organic layers to 3" in upper ½, wood fragments in lower half, moist to wet
6. SANDY SILTY CLAY, brown to red-brown, layers of fine sand to ¼", iron stained silty clay nodules, moist to wet
7. SILTY SANDY CLAY, brown to red-brown, w/sand layers & lenses to ¼", wet
8. SILTY CLAY, brown to red-brown, wet

FINAL SURVEY — NOTE BOOK — NO. — SURVEYED — PLOTTED — TEMPLATE — AREAS — AREAS CHECKED

ORIGINAL SURVEY — NOTE BOOK — NO. — SURVEYED — PLOTTED — TEMPLATE — AREAS — AREAS CHECKED — BY — DATE

U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

MELDAHL POOL

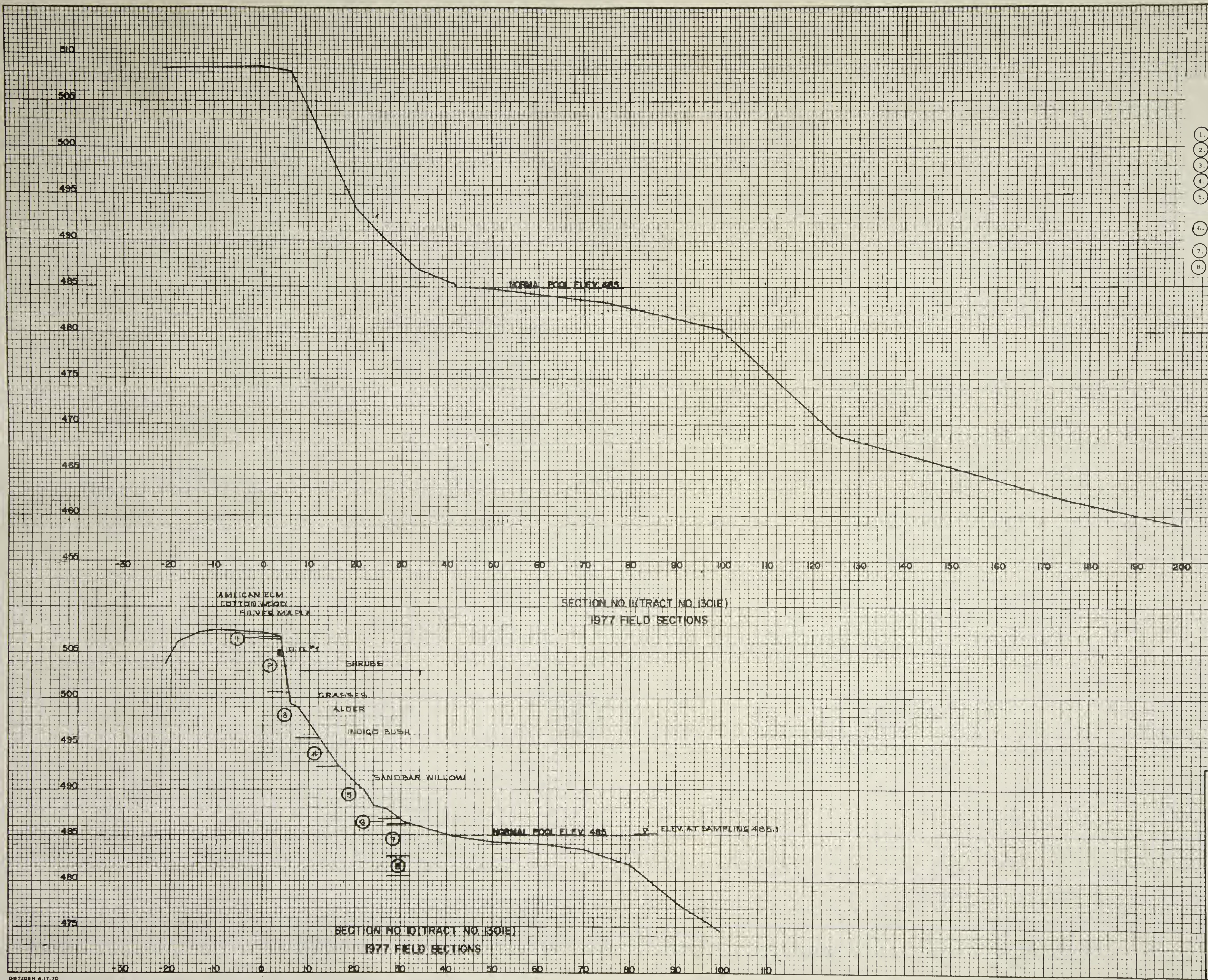
DONALD R. & MARY McNELLY, TRACT NO. 1301E

SOIL & VEGETATION PROFILE

MILE 412.6

ORDXE JULY 77

DIETZGEN 8-17-70
FORM NO. A



McNELLY

Tract 1301E

1. SILTY CLAY, light brown, w/rootlets & worm casts, dry (topsoil)
2. SILTY SANDY CLAY, brown, w/rootlets & worm casts, damp
3. SANDY SILTY CLAY, brown, w/fine sandy layers, damp to moist
4. SANDY SILTY CLAY, mottled brown to gray, w/wood fragments, wet to damp
5. SILTY SANDY CLAY, light brown to gray, w/layers of fine silty sand ranging from 13" thick in upper ½ to 2" in bottom 1/3, organic layers to 3" in upper ½, wood fragments in lower half, moist to wet
6. SANDY SILTY CLAY, brown to red-brown, layers of fine sand to ½", iron stained silty clay nodules, moist to wet
7. SILTY SANDY CLAY, brown to red-brown, w/sand layers & lenses to ½", wet
8. SILTY CLAY, brown to red-brown, wet

U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY

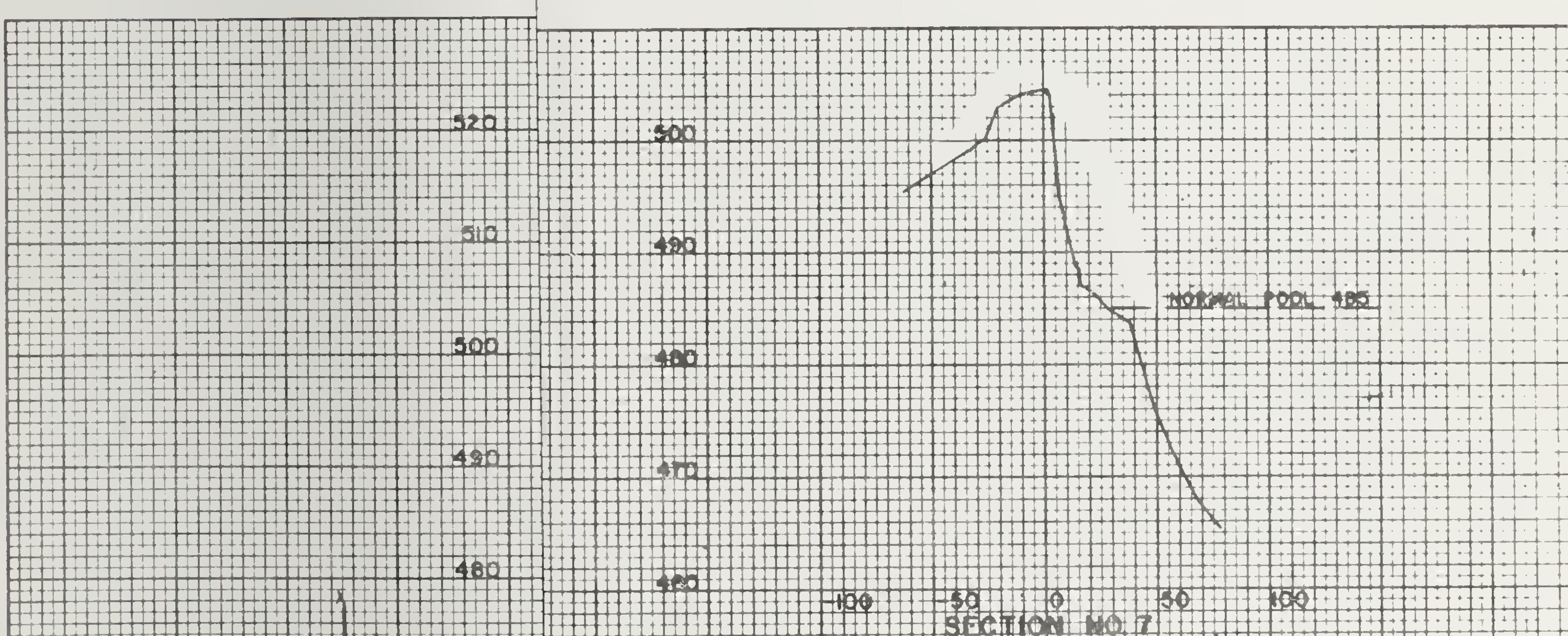
MELDAHL POOL

DONALD R. & MARY McNELLY, TRACT NO. 1301E
SOIL & VEGETATION PROFILE
MILE 412.6

ORDXE JULY 77

PLATE 33

MAPPING BASED ON 22 MAR. 77 PHOTOGRAPHY



U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

MELDAHL POOL

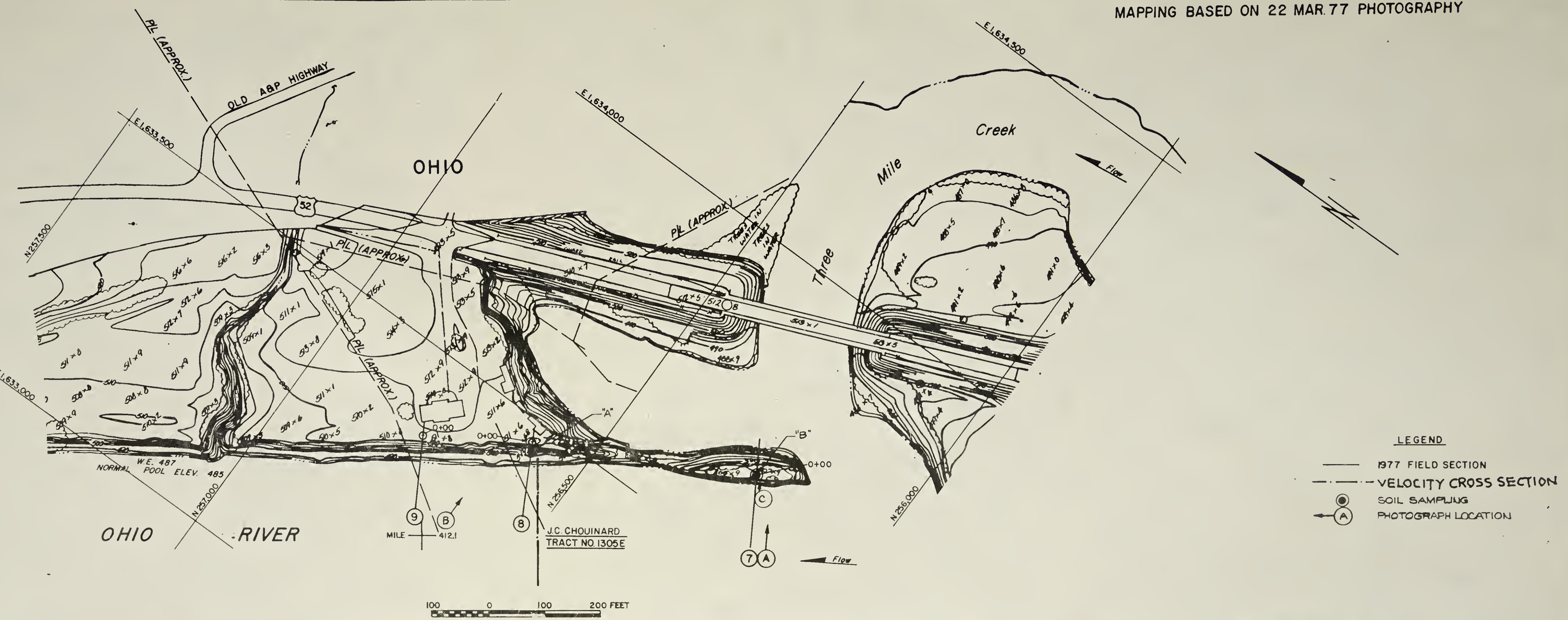
JAMES & CHERYL CHOUINARD, TRACT NO. 1305E

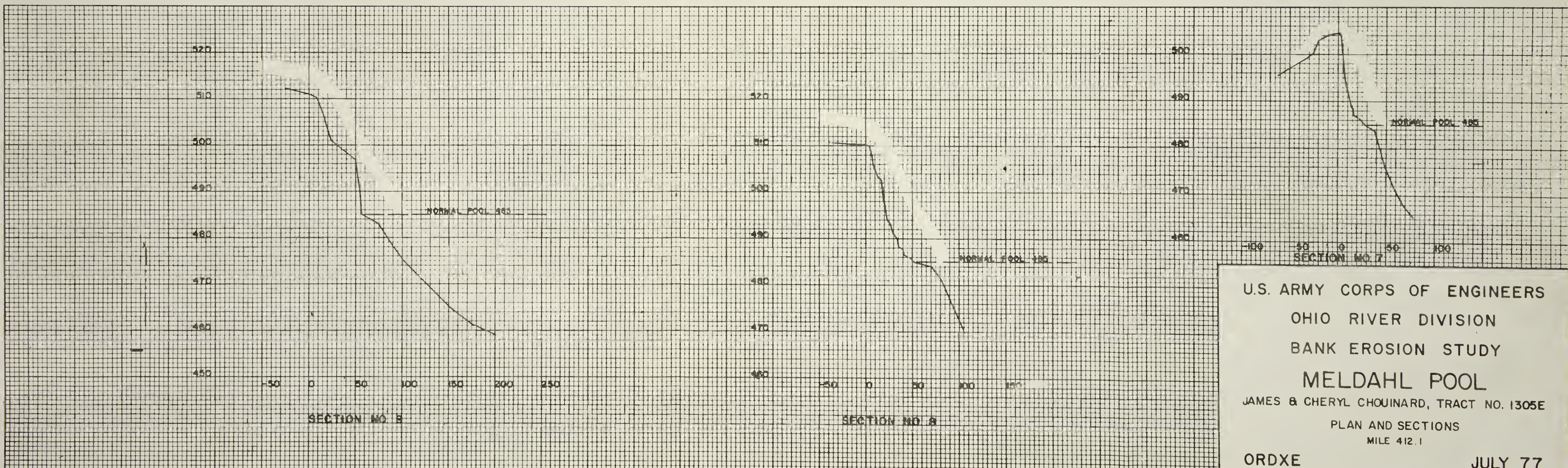
PLAN AND SECTIONS

MILE 412.1

ORDXE JULY 77

MAPPING BASED ON 22 MAR. 77 PHOTOGRAPHY





U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

MELDAHL POOL

JAMES & CHERYL CHOUINARD, TRACT NO. 1305E

PLAN AND SECTIONS

MILE 412.1

ORDXE JULY 77

PLATE 34

SHEET 1 OF 3

COUNTY OF	FISCAL YEAR	SHEET NO	TOTAL SHEETS

CHOUINARD

Tract 1305E

(Site 19B)

1. SAND, dark brown, fine to medium grained, rootlets in upper half, damp
2. SILTY SAND, brown, grading finer w/depth, rootlets, damp
3. SANDY SILTY, brown, rootlets, damp, grades finer w/depth
4. SANDY SILTY CLAY, brown, w/roots, blocky, damp
5. SILTY SANDY CLAY, brown to dark gray, sandy layers & layers of coal fines, damp, recent deposit

FINAL SURVEY		BY	DATE
NOTE BOOK	SURVEYED		
	PLOTTED		
	TEMPLATE		
	AREAS		
NO	AREAS CHECKED		

ORIGINAL SURVEY		BY	DATE
NOTE BOOK	SURVEYED		
	PLOTTED		
	TEMPLATE		
	AREAS		
NO	AREAS CHECKED		

U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

MELDAHL POOL

JAMES & CHERYL CHOUINARD, TRACT NO. 1305E

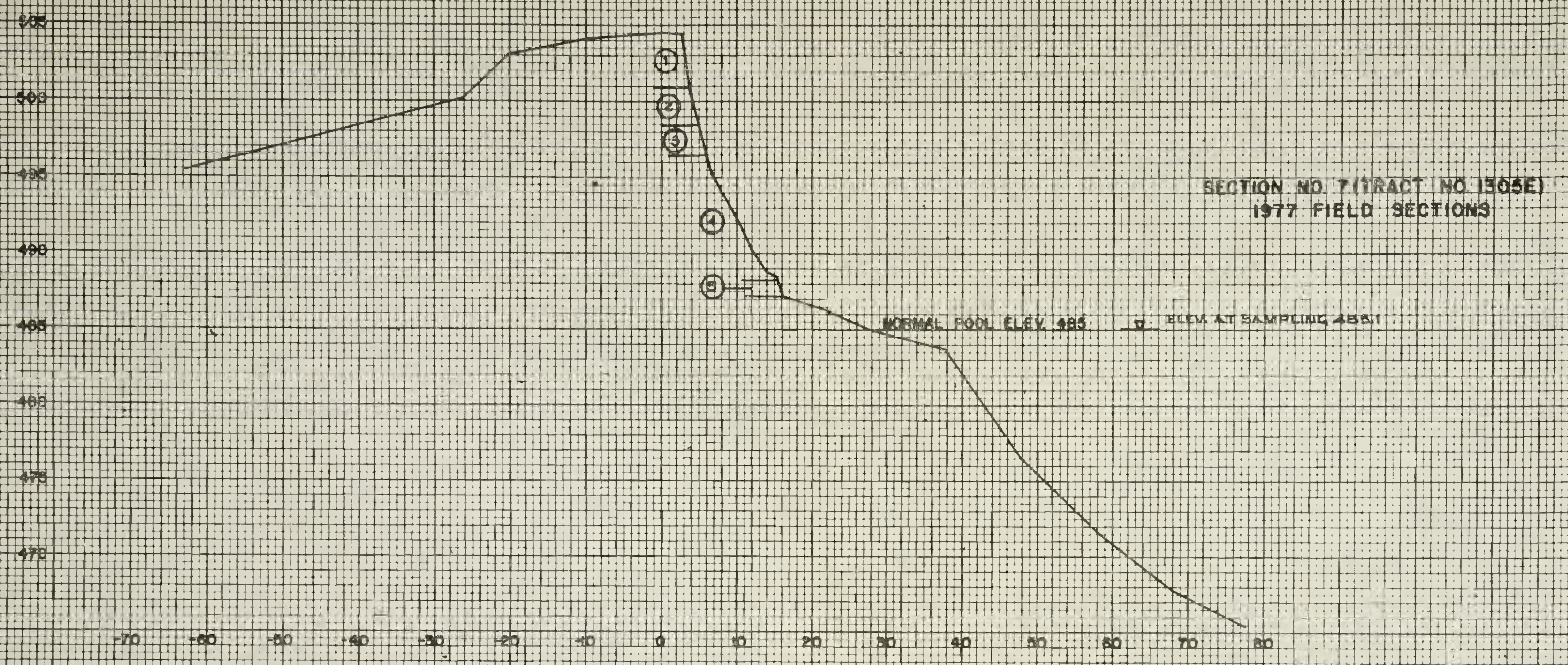
SOIL PROFILE

MILE 412.1

ORDXE JULY 77

DIETZGEN 8-17-70
FORM NO. 8

COUNTY OF	FISCAL YEAR	SHEET NO	TOTAL SHEETS

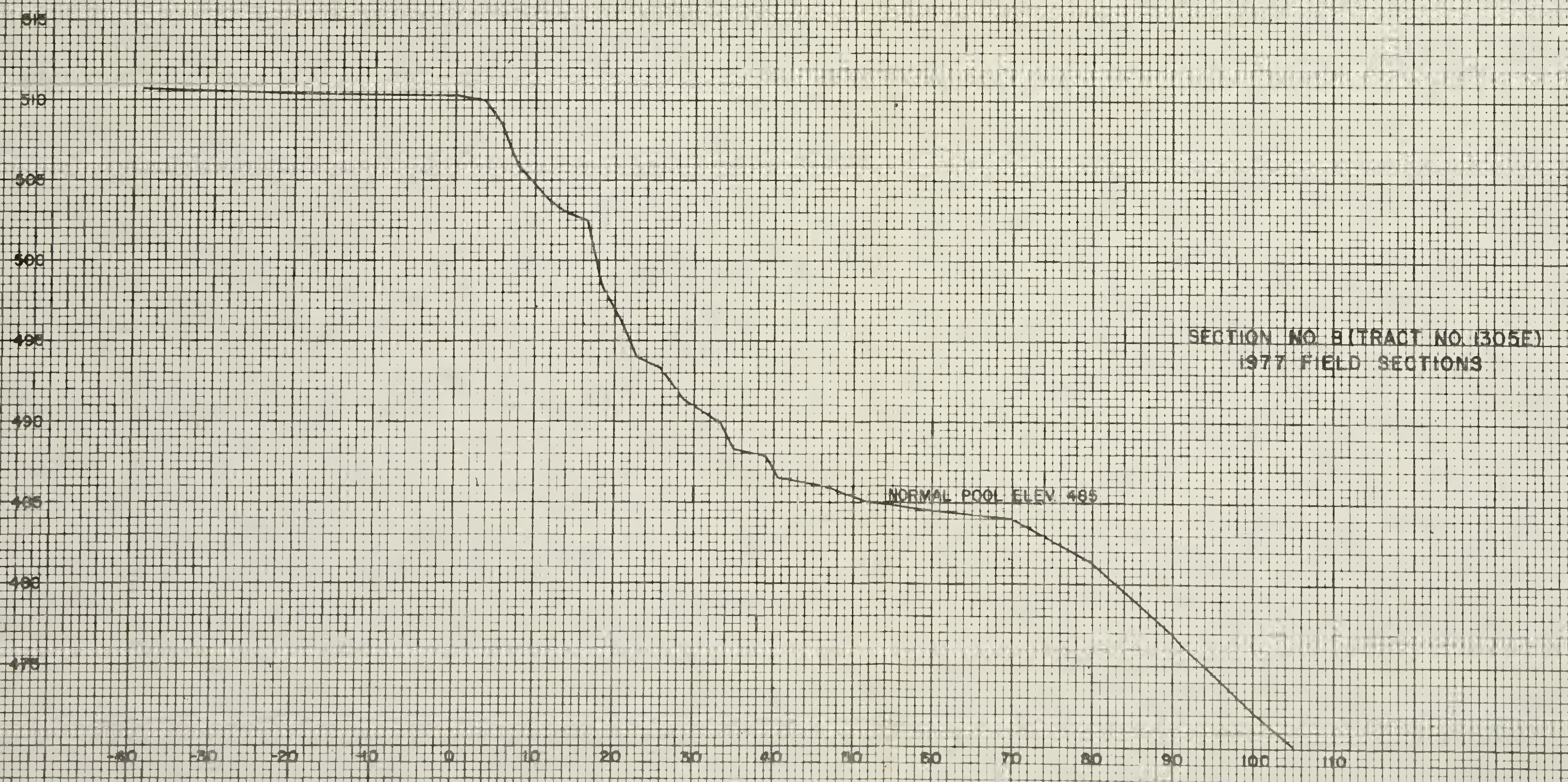


CHOUINARD

Tract 1305E

(Site 19B)

1. SAND, dark brown, fine to medium grained, rootlets in upper half, damp
2. SILTY SAND, brown, grading finer w/depth, rootlets, damp
3. SANDY SILTY, brown, rootlets, damp, grades finer w/depth
4. SANDY SILTY CLAY, brown, w/roots, blocky, damp
5. SILTY SANDY CLAY, brown to dark gray, sandy layers & layers of coal fines, damp, recent deposit



U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

MELDAHL POOL

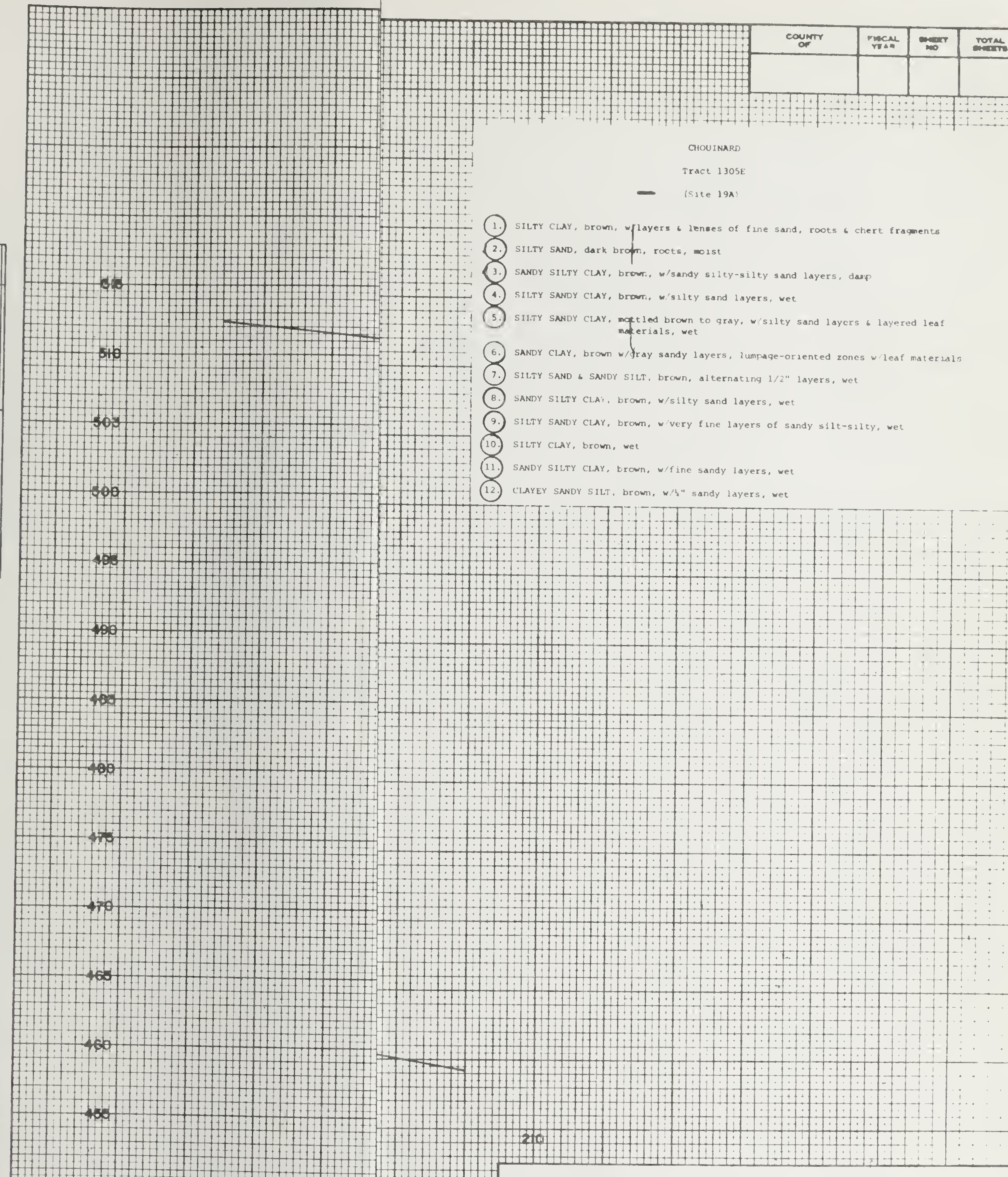
JAMES & CHERYL CHOUINARD, TRACT NO. 1305E

SOIL PROFILE

MILE 412.1

ORDXE . JULY 77

COUNTY OF	FISCAL YEAR	SHEET NO	TOTAL SHEETS



CHOUINARD

Tract 1305E

(Site 19A)

1. SILTY CLAY, brown, w/layers & lenses of fine sand, roots & chert fragments
2. SILTY SAND, dark brown, roots, moist
3. SANDY SILTY CLAY, brown, w/sandy silty-silty sand layers, damp
4. SILTY SANDY CLAY, brown, w/silty sand layers, wet
5. SILTY SANDY CLAY, mottled brown to gray, w/silty sand layers & layered leaf materials, wet
6. SANDY CLAY, brown w/gray sandy layers, lumpage-oriented zones w/leaf materials
7. SILTY SAND & SANDY SILT, brown, alternating 1/2" layers, wet
8. SANDY SILTY CLAY, brown, w/silty sand layers, wet
9. SILTY SANDY CLAY, brown, w/very fine layers of sandy silt-silty, wet
10. SILTY CLAY, brown, wet
11. SANDY SILTY CLAY, brown, w/fine sandy layers, wet
12. CLAYEY SANDY SILT, brown, w/½" sandy layers, wet

FINAL SURVEY		BY	DATE
NOTE BOOK	SURVEYED		
NO.	PLOTTED		
	TEMPLATE		
	AREAS		
	AREAS CHECKED		

ORIGINAL SURVEY		BY	DATE
NOTE BOOK	SURVEYED		
NO.	PLOTTED		
	TEMPLATE		
	AREAS		
	AREAS CHECKED		

U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY

MELDAHL POOL

JAMES & CHERYL CHOUINARD, TRACT NO. 1305E

SOIL PROFILE

MILE 412.1

ORDXE JULY 77

DIETZGEN 8-17-70
FORM NO. 8

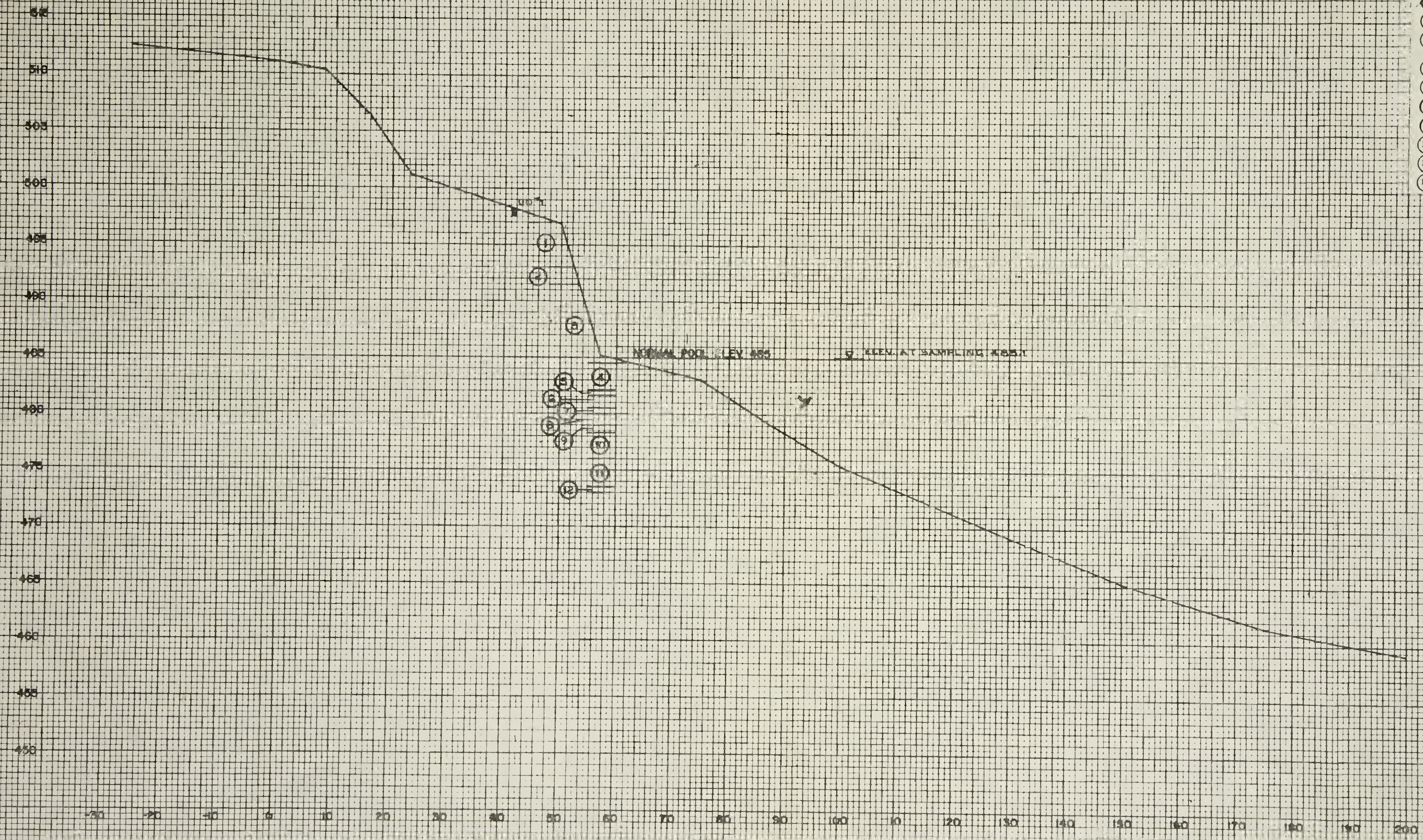
COUNTY OF	FISCAL YEAR	SHEET NO	TOTAL SHEETS

CHOUINARD

Tract 1305E

(Site 19A)

1. SILTY CLAY, brown, w/layers & lenses of fine sand, roots & chert fragments
2. SILTY SAND, dark brown, roots, moist
3. SANDY SILTY CLAY, brown, w/sandy silty-silty sand layers, damp
4. SILTY SANDY CLAY, brown, w/silty sand layers, wet
5. SILTY SANDY CLAY, mottled brown to gray, w/silty sand layers & layered leaf materials, wet
6. SANDY CLAY, brown w/gray sandy layers, lumpage-oriented zones w/leaf materials
7. SILTY SAND & SANDY SILT, brown, alternating 1/2" layers, wet
8. SANDY SILTY CLAY, brown, w/silty sand layers, wet
9. SILTY SANDY CLAY, brown, w/very fine layers of sandy silt-silty, wet
10. SILTY CLAY, brown, wet
11. SANDY SILTY CLAY, brown, w/fine sandy layers, wet
12. CLAYEY SANDY SILT, brown, w/¼" sandy layers, wet



SECTION NO. 9 (TRACT NO. 1305E)
1977 FIELD SECTIONS

FINAL SURVEY	NOTE BOOK	SURVEYED	PLOTTED	TEMPLATE	AREAS	AREAS CHECKED
	BY					
	DATE					

ORIGINAL SURVEY	NOTE BOOK	SURVEYED	PLOTTED	TEMPLATE	AREAS	AREAS CHECKED
	BY					
	DATE					

U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY

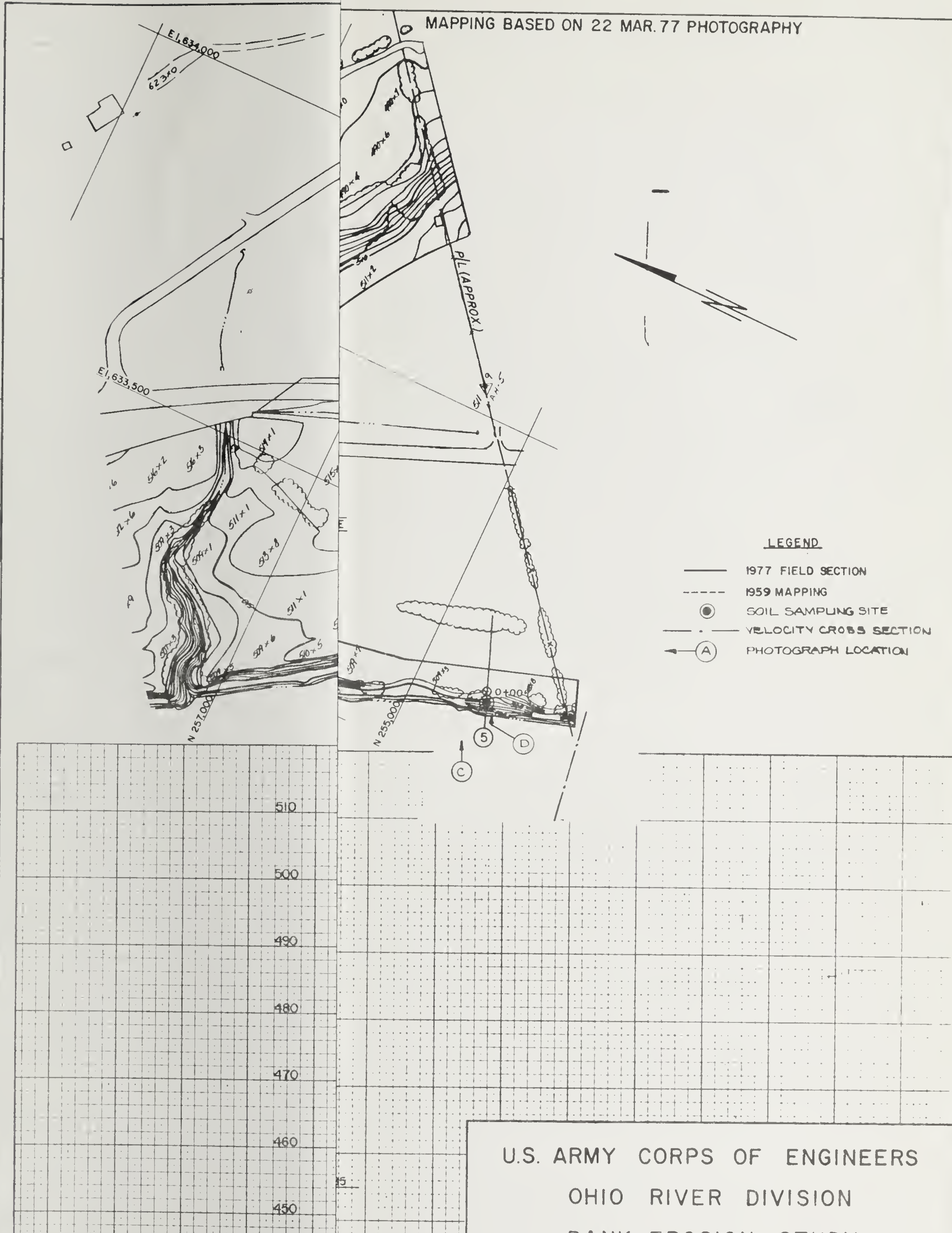
MELDAHL POOL

JAMES & CHERYL CHOUINARD, TRACT NO. 1305E

SOIL PROFILE
MILE 412.1

ORDXE JULY 77

DIETZGEN 6-7-70
FORM NO. 8



U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

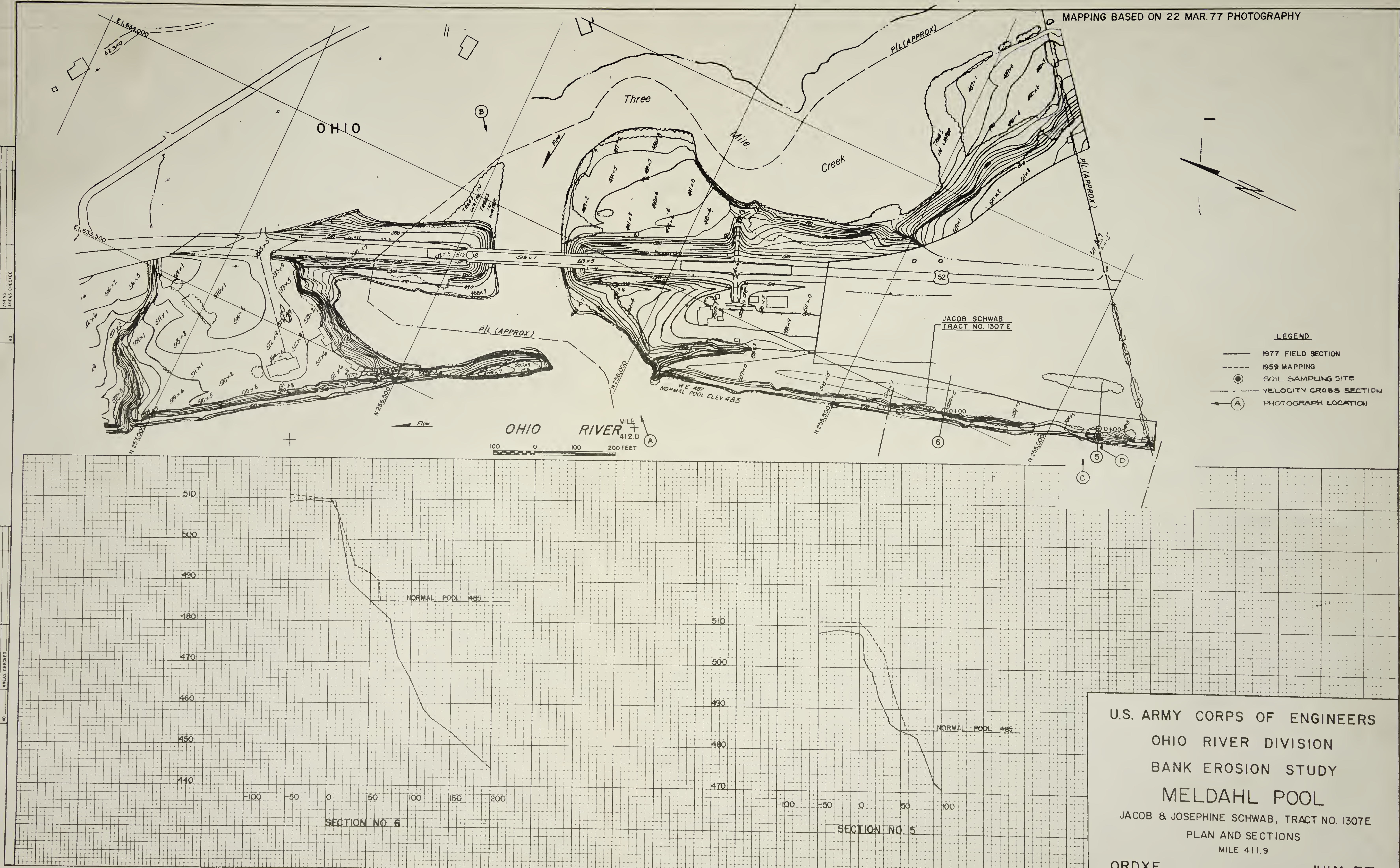
MELDAHL POOL

JACOB & JOSEPHINE SCHWAB, TRACT NO. 1307E

PLAN AND SECTIONS

MILE 411.9

ORDXE JULY 77



U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

MELDAHL POOL

JACOB & JOSEPHINE SCHWAB, TRACT NO. 1307E

PLAN AND SECTIONS

MILE 411.9

ORDXE

JULY 77

COUNTY OF	FISCAL YEAR	SHEET NO	TOTAL SHEETS

SCHWAB

Tract 1307E

1 SANDY SILTY CLAY, brown, blocky, iron stain, rootlets, damp

2 SILTY CLAY, brown, iron-stained, with silty sand lenses, damp

4 SILTY SANDY CLAY, brown, iron-stained, most

5 SANDY SILTY CLAY, brown, moist

6 SILTY CLAY, brown, with 1/4" sand lenses, damp

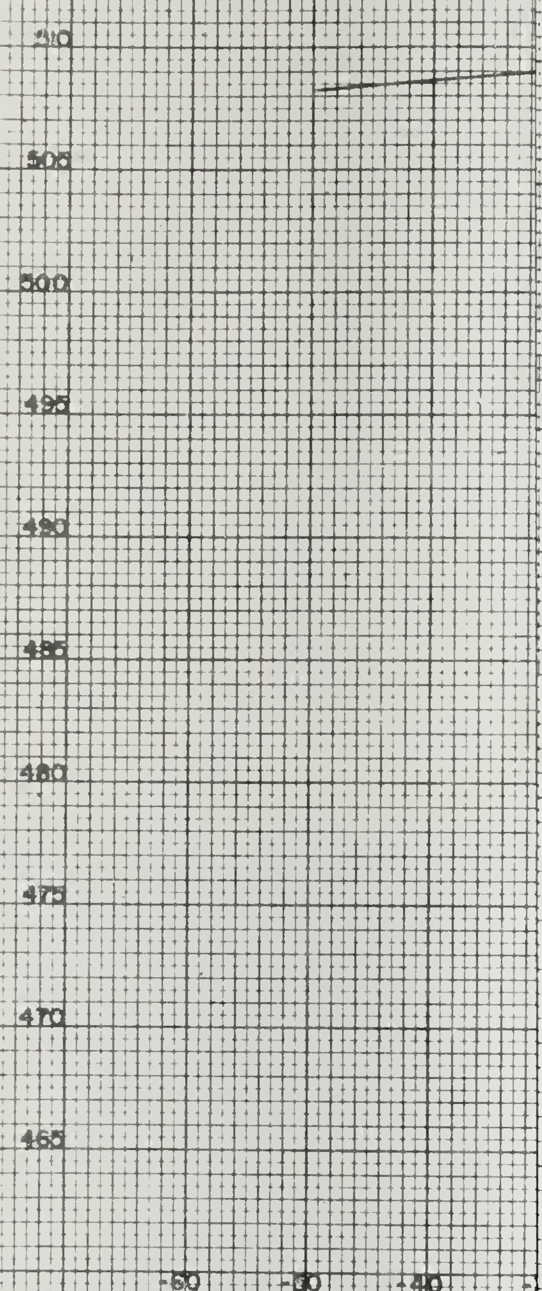
7 SILTY SANDY CLAY, brown, moist

8 SANDY CLAY, brown, with 1/4' sand lenses, moist to wet

9 SANDY CLAY, brown, with fine 1/8" sand lenses, iron-stained, moist to wet

10 SANDY CLAY, brown, with brown to gray fine sand layers, 2" layer black organic material, wet

11 SANDY SILTY CLAY, brown, with lenses of fine sand, wet



FINAL SURVEY NOTE BOOK NO
SURVEYED PLOTTED TEMPLATE AREAS AREAS CHECKED
BY DATE

ORIGINAL SURVEY NOTE BOOK NO
SURVEYED PLOTTED TEMPLATE AREAS AREAS CHECKED
BY DATE

U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

MELDAHL POOL

JACOB & JOSEPHINE SCHWAB, TRACT NO. 1307E

SOIL PROFILE

MILE 411.4

ORDXE JULY 77

DIETZGEN 8-17-70
FORM NO. 8

PLATE 35 SHEET 2 OF 2

PLATE 36 SHEET 1 OF 3

COUNTY OF	FISCAL YEAR	SHEET NO	TOTAL SHEETS

SCHWAB

Tract 1307E

1 SANDY SILTY CLAY, brown, blocky, iron stain, rootlets, damp

2 SILTY CLAY, brown, iron-stained, with silty sand lenses, damp

4 SILTY SANDY CLAY, brown, iron-stained, most

5 SANDY SILTY CLAY, brown, moist

6 SILTY CLAY, brown, with 1/4" sand lenses, damp

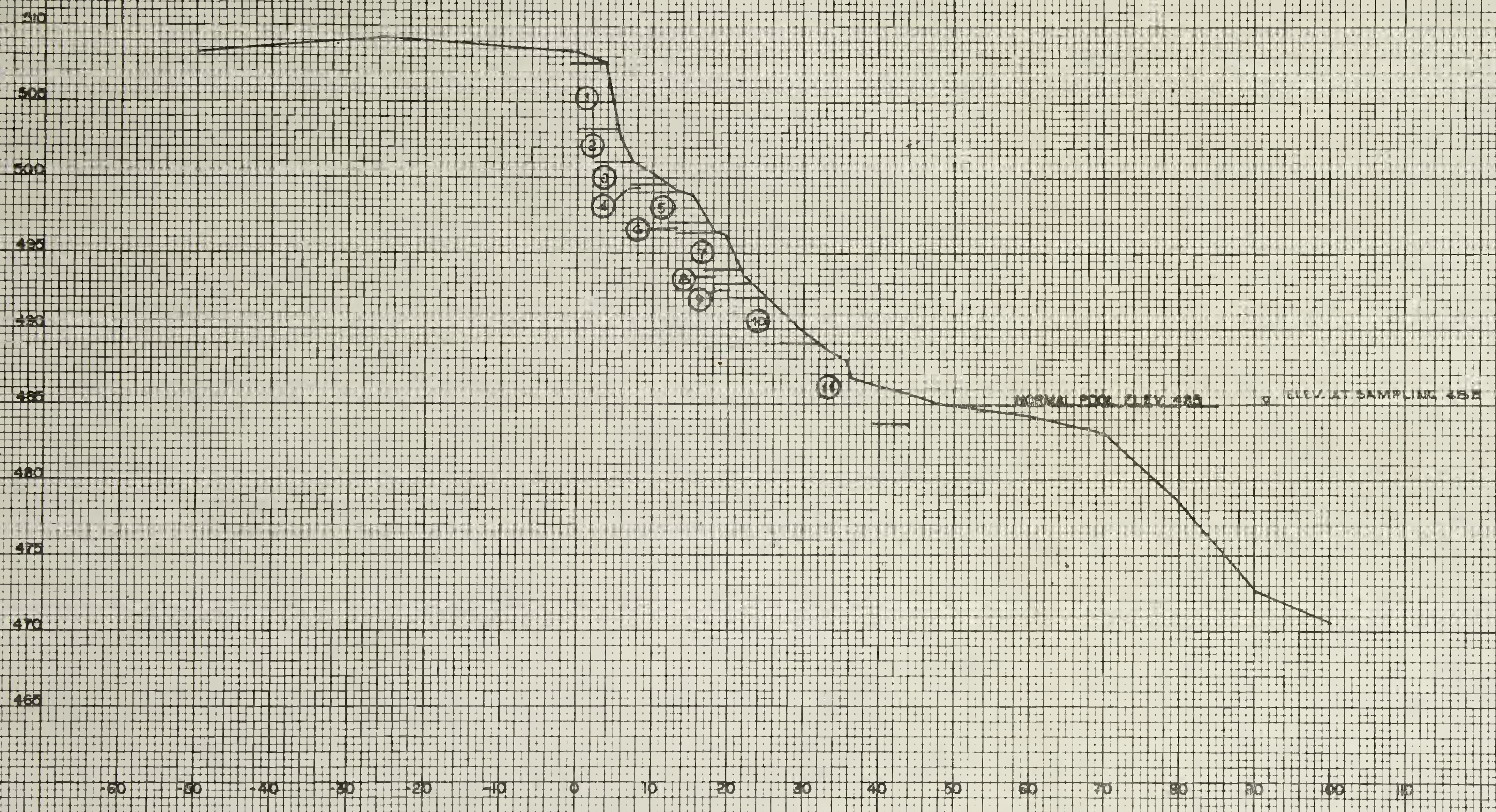
7 SILTY SANDY CLAY, brown, moist

8 SANDY CLAY, brown, with 1/4' sand lenses, moist to wet

9 SANDY CLAY, brown, with fine 1/8" sand lenses, iron-stained, moist to wet

10 SANDY CLAY, brown, with brown to gray fine sand layers, 2" layer black organic material, wet

11 SANDY SILTY CLAY, brown, with lenses of fine sand, wet



SECTION NO. 5 (TRACT NO. 1307E)
1977 FIELD SECTIONS

U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY

MELDAHL POOL

JACOB & JOSEPHINE SCHWAB, TRACT NO. 1307E

SOIL PROFILE

MILE 411.4

ORDXE JULY 77

MAPPING BASED ON 22 MAR. 77 PHOTOGRAPHY

LEGEND

1977 FIELD SECTIONS

(A) PHOTOGRAPH LOCATION

U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

MELDAHL POOL

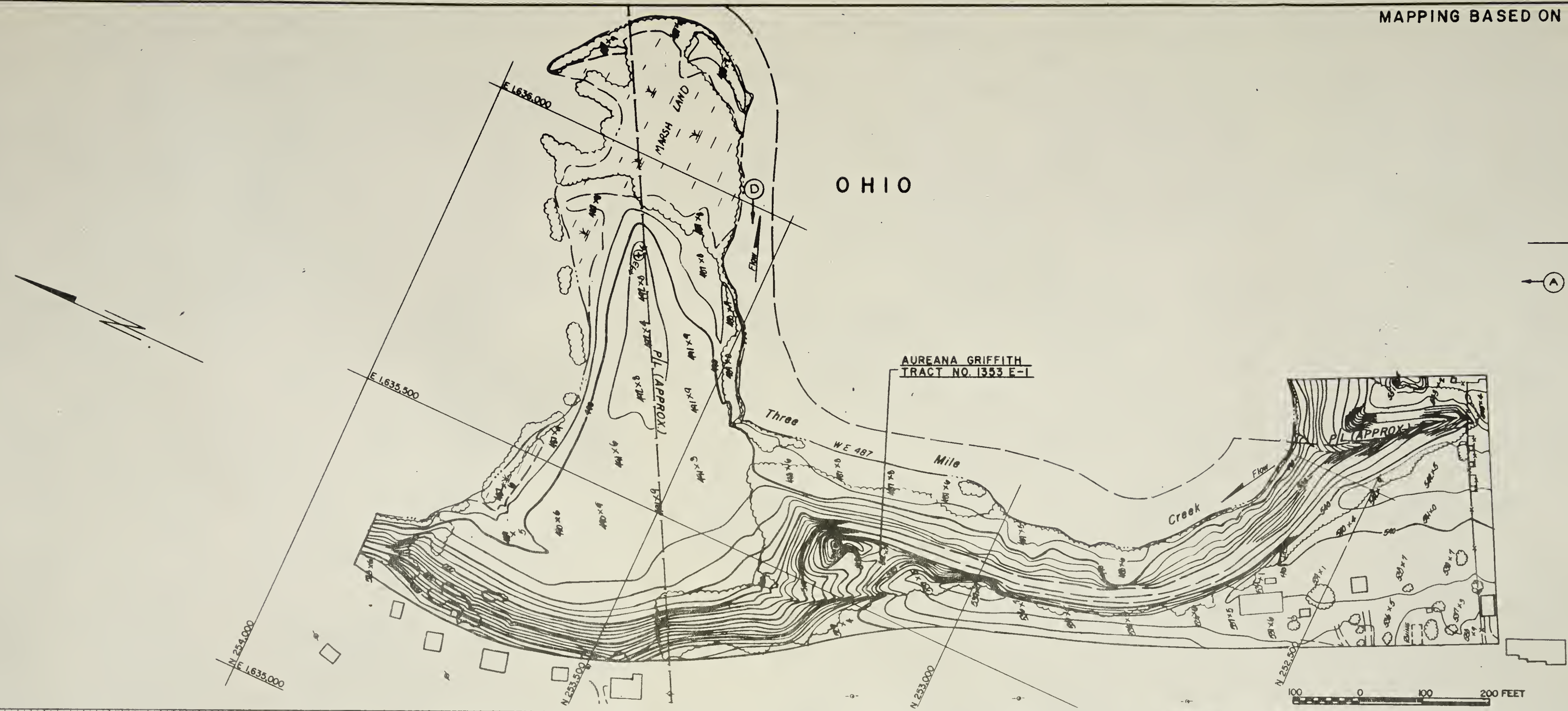
BERNARD GRIFFITH, TRACT NO. 1353E-1 & 2

PLAN

MILE 411.3

ORDXE JULY 77

MAPPING BASED ON 22 MAR. 77 PHOTOGRAPHY



NO SECTIONS

FINAL SURVEY	SURVEYED	BY	DATE
NOTE BOOK	PLOTTED		
NO.	TEMPLATE		
	AREAS		
	AREAS CHECKED		

ORIGINAL SURVEY	SURVEYED	BY	DATE
NOTE BOOK	PLOTTED		
NO.	TEMPLATE		
	AREAS		
	AREAS CHECKED		

U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY

MELDAHL POOL

BERNARD GRIFFITH, TRACT NO. 1353E-1 & 2

PLAN

MILE 411.3

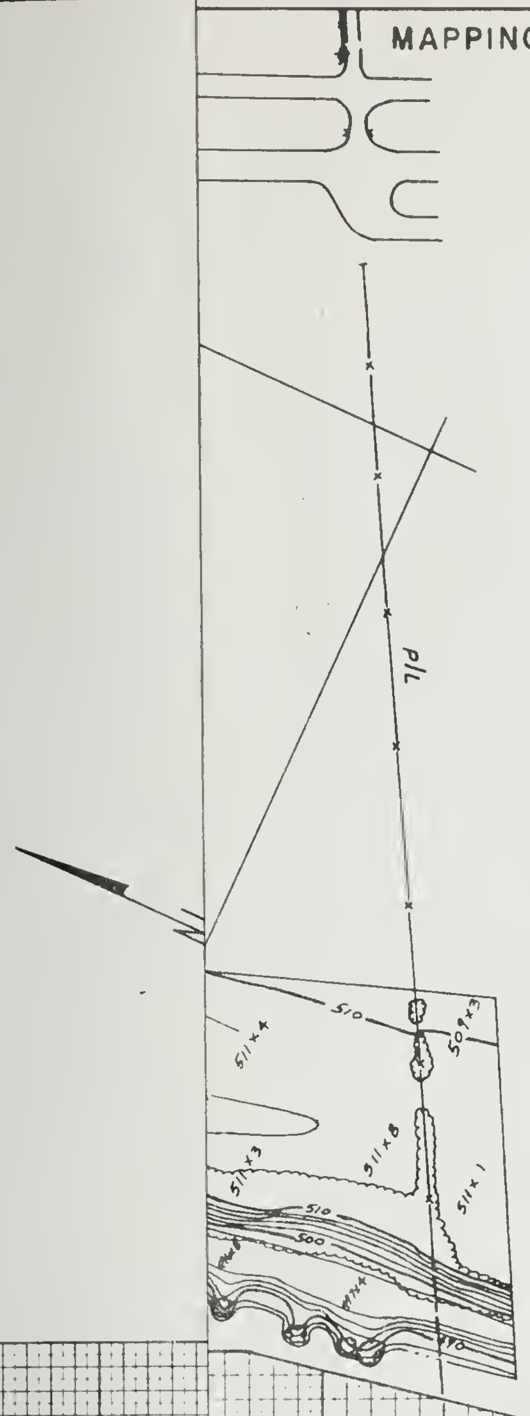
ORDXE

JULY 77

PLATE 36

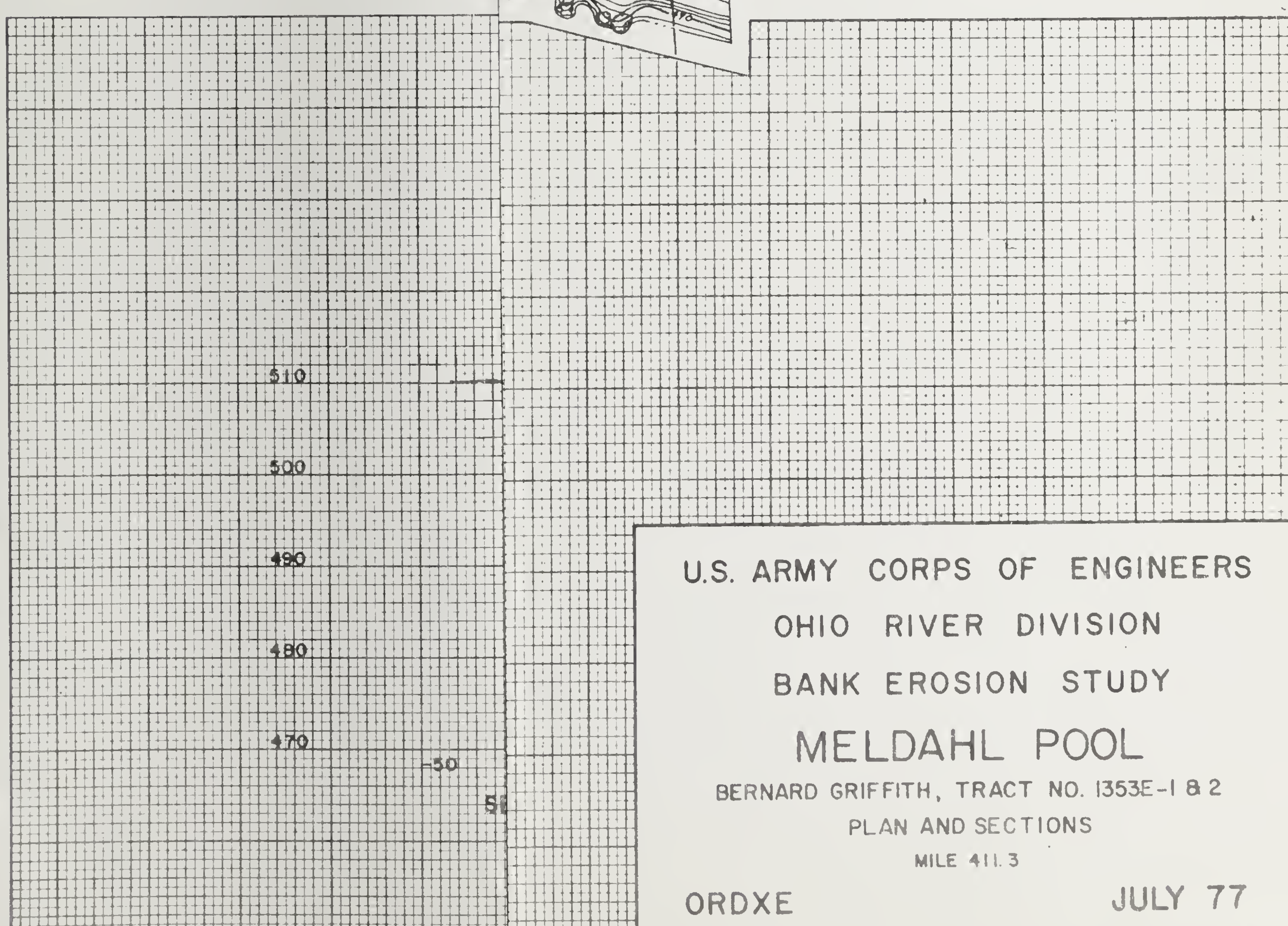
SHEET 1 OF 3

MAPPING BASED ON 22 MAR. 77 PHOTOGRAPHY



LEGEND

- 1977 FIELD SECTION
- SOIL SAMPLING SITE
- WAVE MEASUREMENT SITE
- VELOCITY CROSS SECTION
- (A) PHOTOGRAPH LOCATION



FINAL SURVEY — NOTE BOOK — NO — SURVEYED — PLOTTED — TEMPLATE — AREAS — AREAS CHECKED — BY — DATE

ORIGINAL SURVEY — NOTE BOOK — NO — SURVEYED — PLOTTED — TEMPLATE — AREAS — AREAS CHECKED — BY — DATE

U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

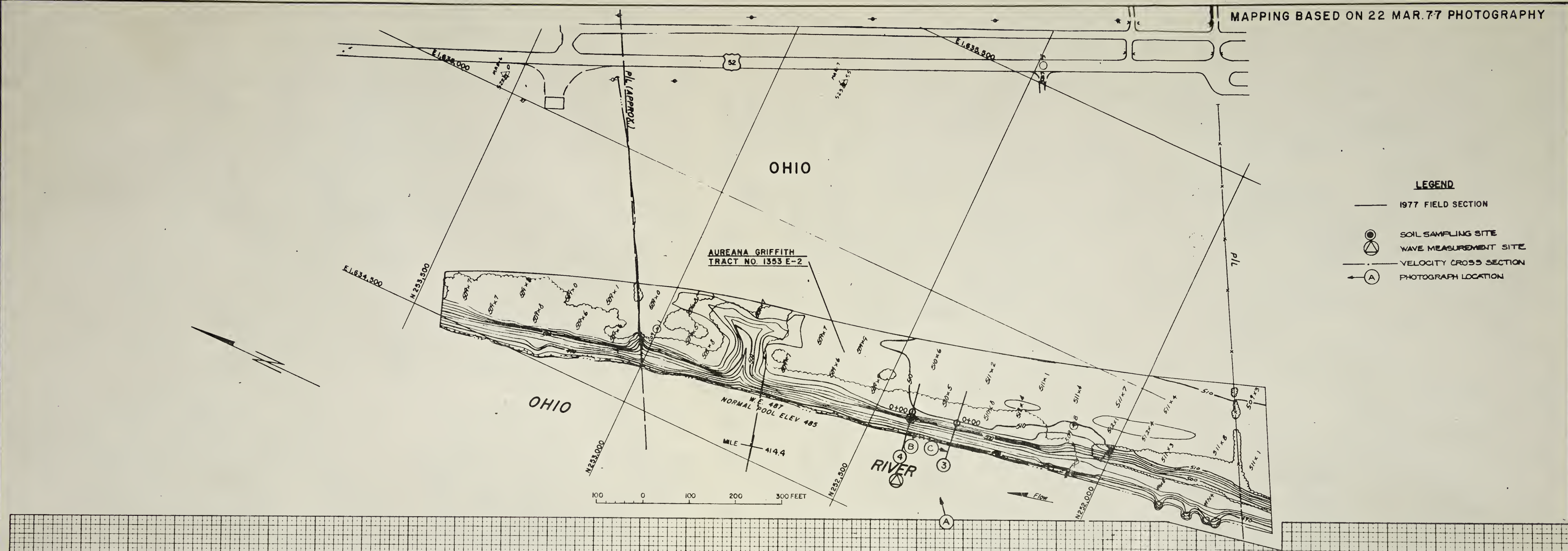
MELDAHL POOL

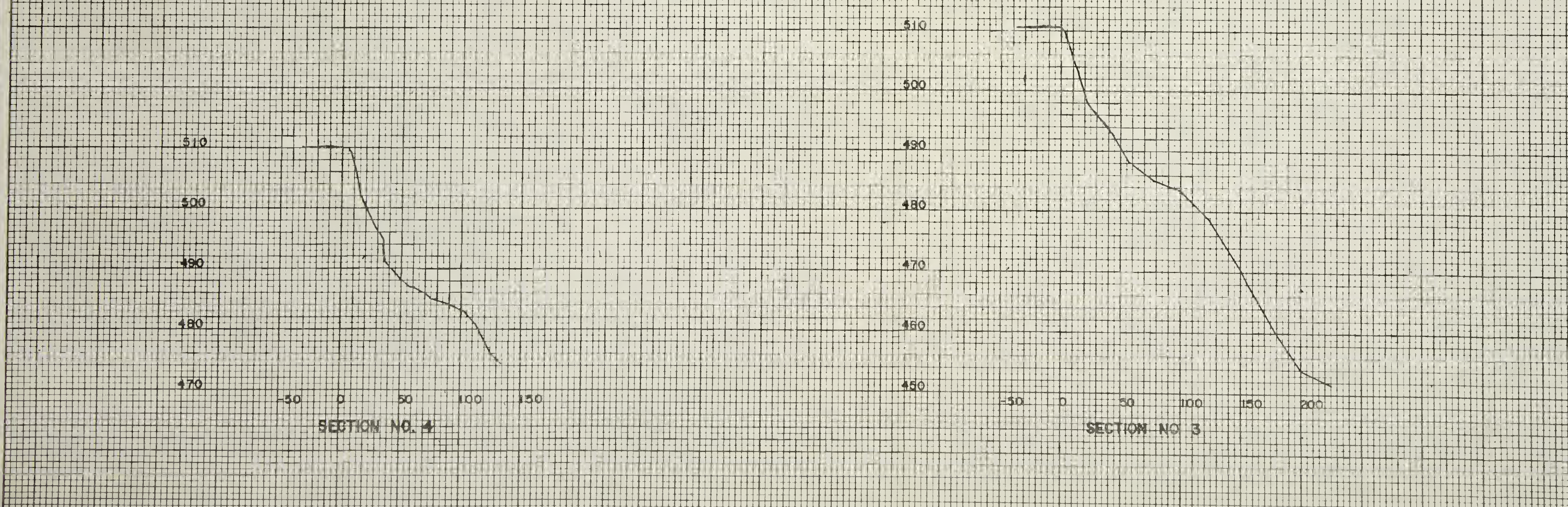
BERNARD GRIFFITH, TRACT NO. 1353E-1 & 2

PLAN AND SECTIONS

MILE 411.3

ORDXE JULY 77





U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY

MELDAHL POOL

BERNARD GRIFFITH, TRACT NO. 1353E-1 & 2
PLAN AND SECTIONS
MILE 411.3

ORDXE JULY 77

PLATE 36 SHEET 2 OF 3

COUNTY OF	FISCAL YEAR	SHEET NO	TOTAL SHEETS

GRIFFITH

Tract 1353E-1&2

1 SANDY SILTY CLAY, dark brown, with rootlets, damp

2 SANDY SILTY CLAY, brown, with fine sand layers, damp

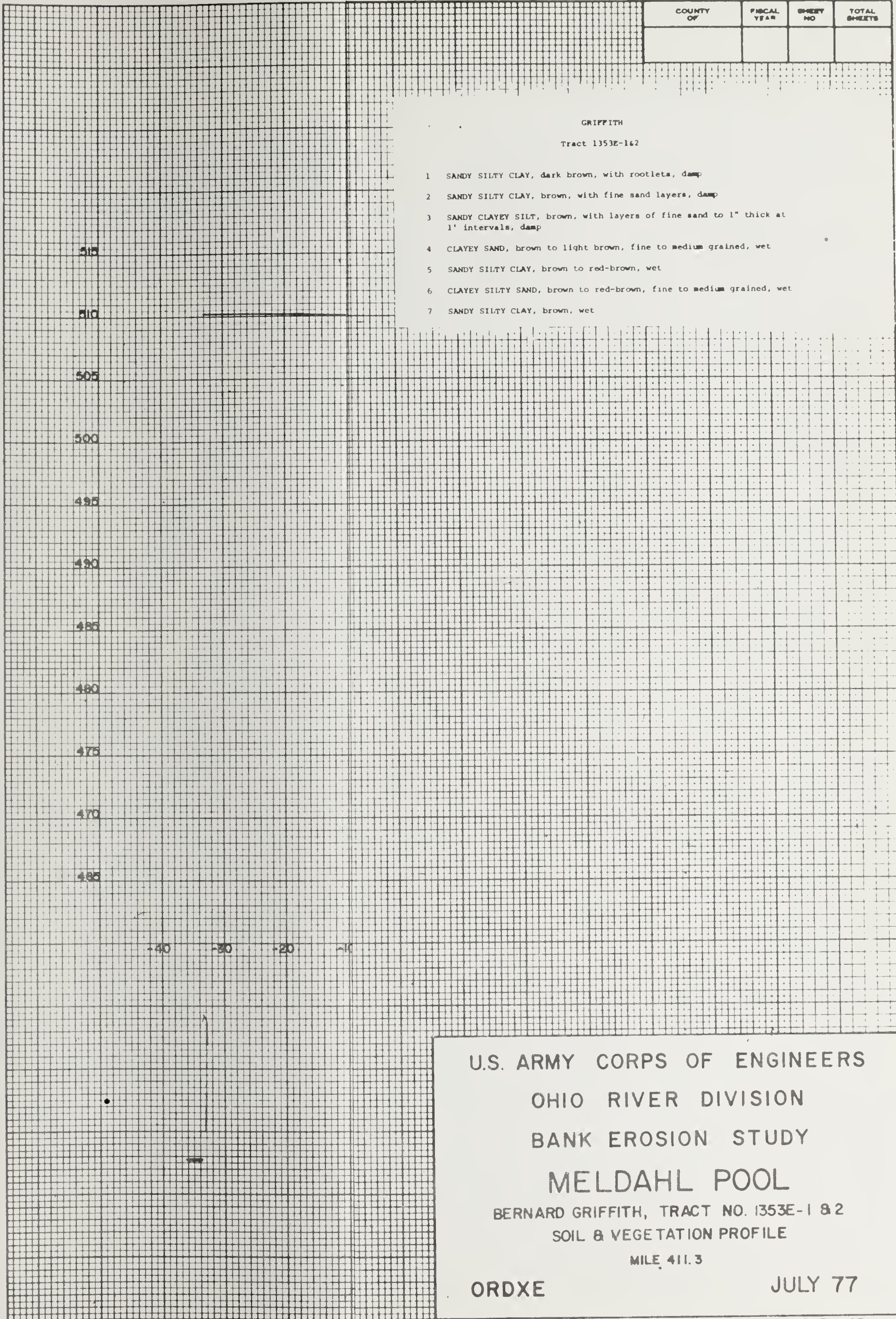
3 SANDY CLAYEY SILT, brown, with layers of fine sand to 1" thick at 1' intervals, damp

4 CLAYEY SAND, brown to light brown, fine to medium grained, wet

5 SANDY SILTY CLAY, brown to red-brown, wet

6 CLAYEY SILTY SAND, brown to red-brown, fine to medium grained, wet

7 SANDY SILTY CLAY, brown, wet



FINAL SURVEY	SURVEYED	BY	DATE
NOTE BOOK	PLOTTED		
	TEMPLATE		
	AREAS		
NO	AREAS CHECKED		

ORIGINAL SURVEY	SURVEYED	BY	DATE
NOTE BOOK	PLOTTED		
	TEMPLATE		
	AREAS		
NO	AREAS CHECKED		

U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

MELDAHL POOL

BERNARD GRIFFITH, TRACT NO. 1353E-1 & 2

SOIL & VEGETATION PROFILE

MILE 411.3

ORDXE JULY 77

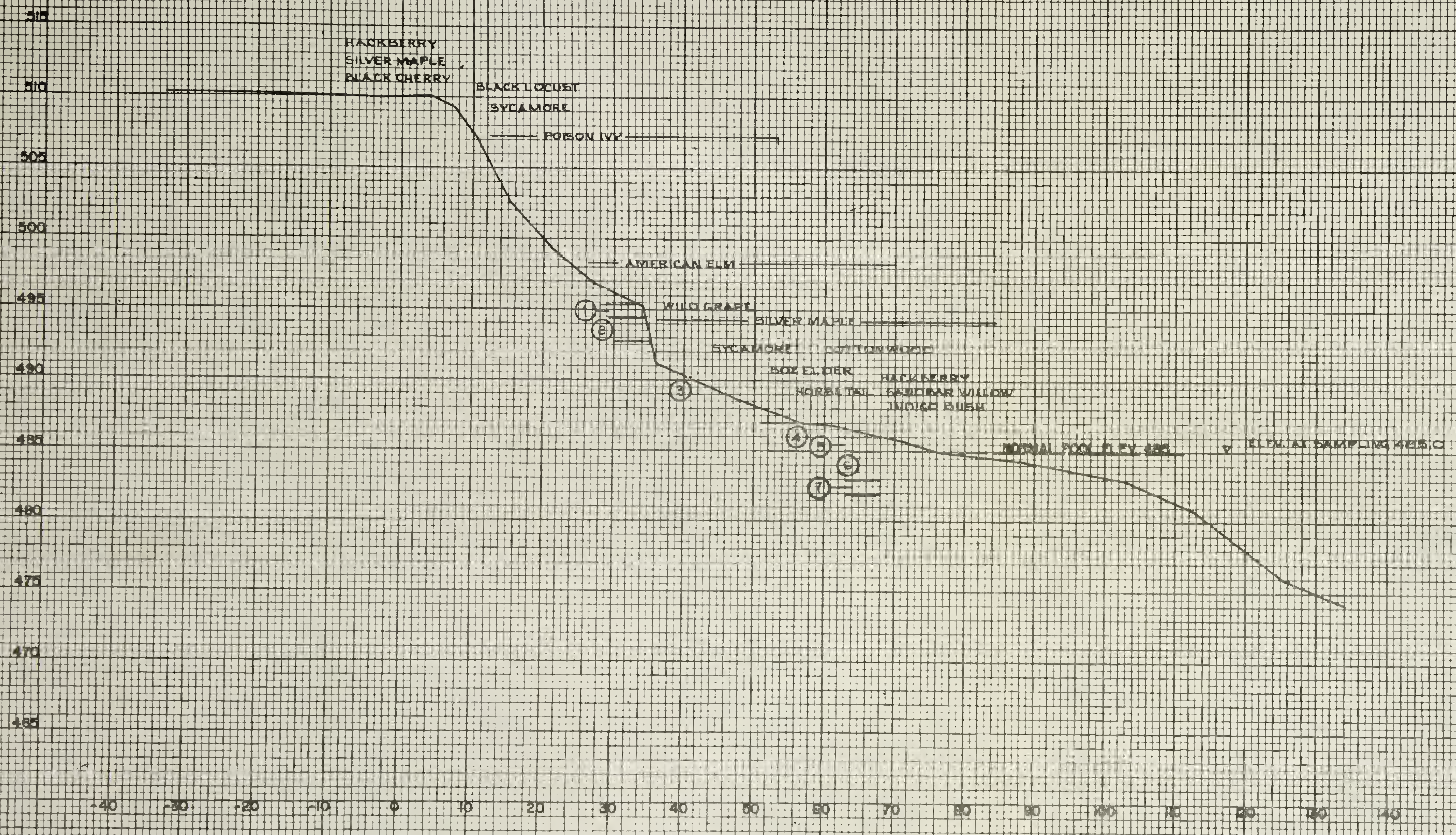
DIETZGEN 6-17-70
FORM NO. 6

COUNTY OF	FISCAL YEAR	SHEET NO	TOTAL SHEETS

GRIFFITH

Tract 1353E-1&2

1 SANDY SILTY CLAY, dark brown, with rootlets, damp
2 SANDY SILTY CLAY, brown, with fine sand layers, damp
3 SANDY CLAYEY SILT, brown, with layers of fine sand to 1" thick at 1" intervals, damp
4 CLAYEY SAND, brown to light brown, fine to medium grained, wet
5 SANDY SILTY CLAY, brown to red-brown, wet
6 CLAYEY SILTY SAND, brown to red-brown, fine to medium grained, wet
7 SANDY SILTY CLAY, brown, wet



SECTION NO. 4 (TRACT NO. 1353E-2)
1977 FIELD SECTIONS

U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY

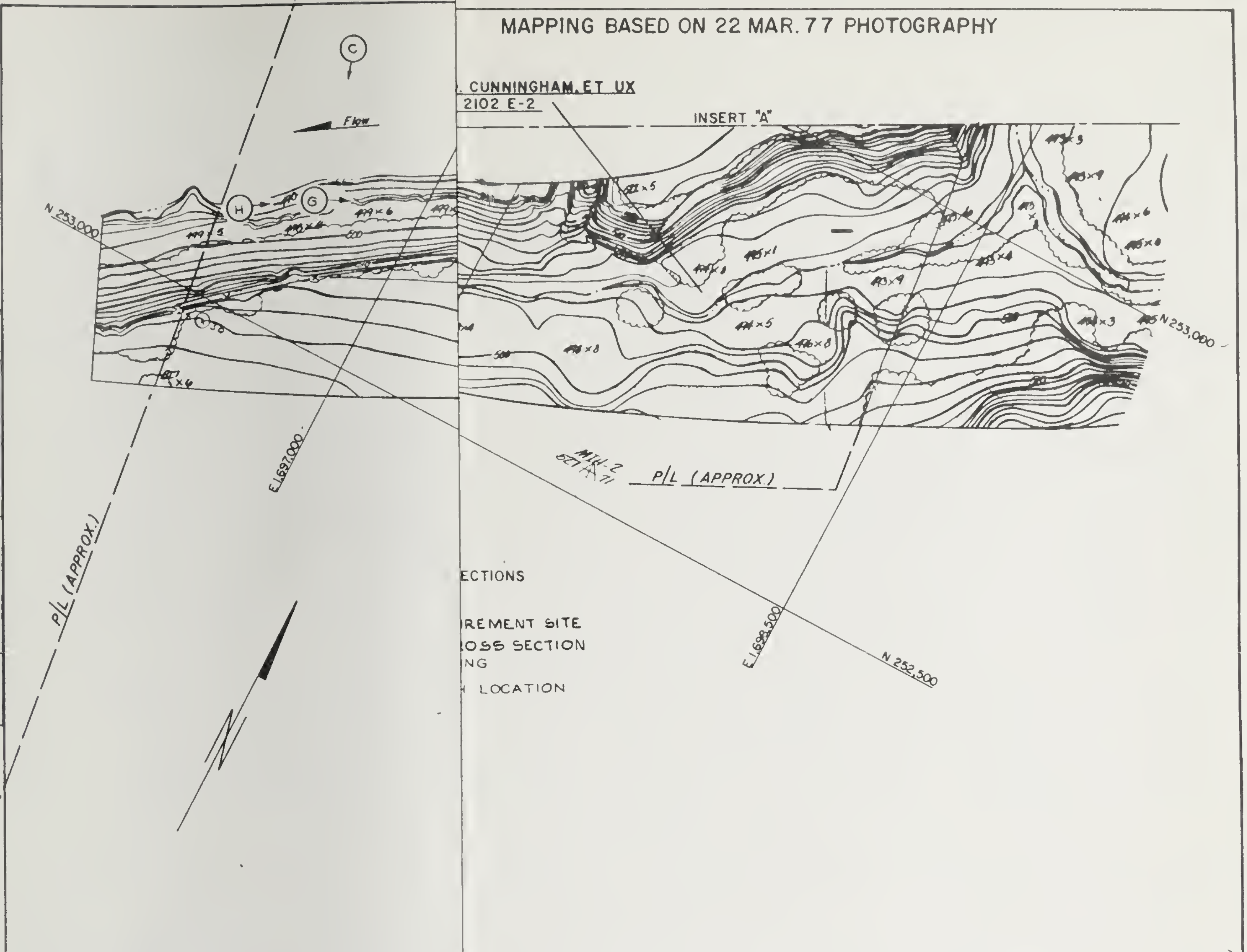
MELDAHL POOL

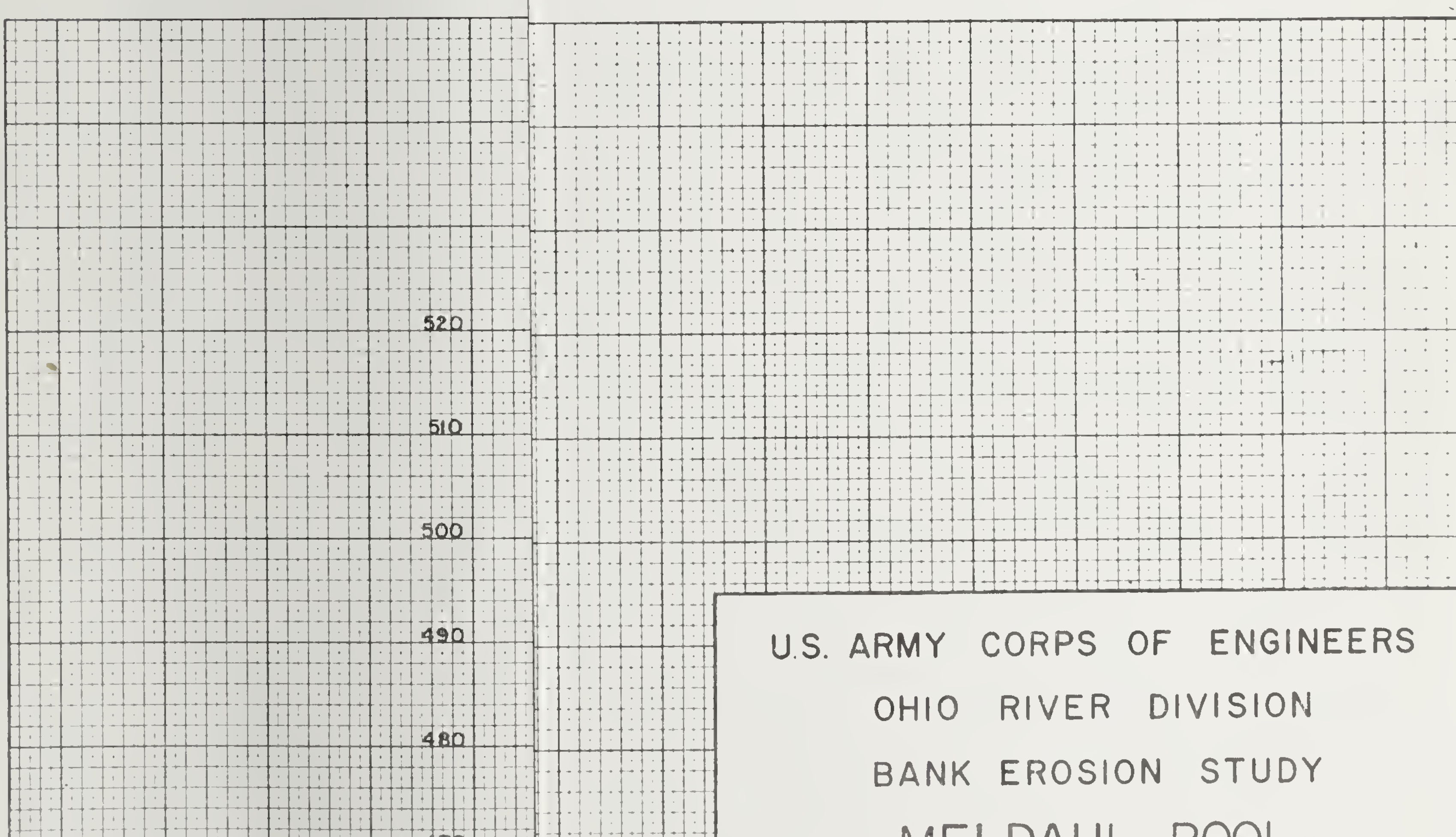
BERNARD GRIFFITH, TRACT NO. 1353E-1 & 2
SOIL & VEGETATION PROFILE
MILE 411.3

ORDXE JULY 77

PLATE 36

MAPPING BASED ON 22 MAR. 77 PHOTOGRAPHY





FINAL SURVEY | NOTE BOOK | NO | SURVEYED | PLOTTED | TEMPLATE | AREAS | AREAS CHECKED | BY | DATE

ORIGINAL SURVEY | NOTE BOOK | NO | SURVEYED | PLOTTED | TEMPLATE | AREAS | AREAS CHECKED | BY | DATE

U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

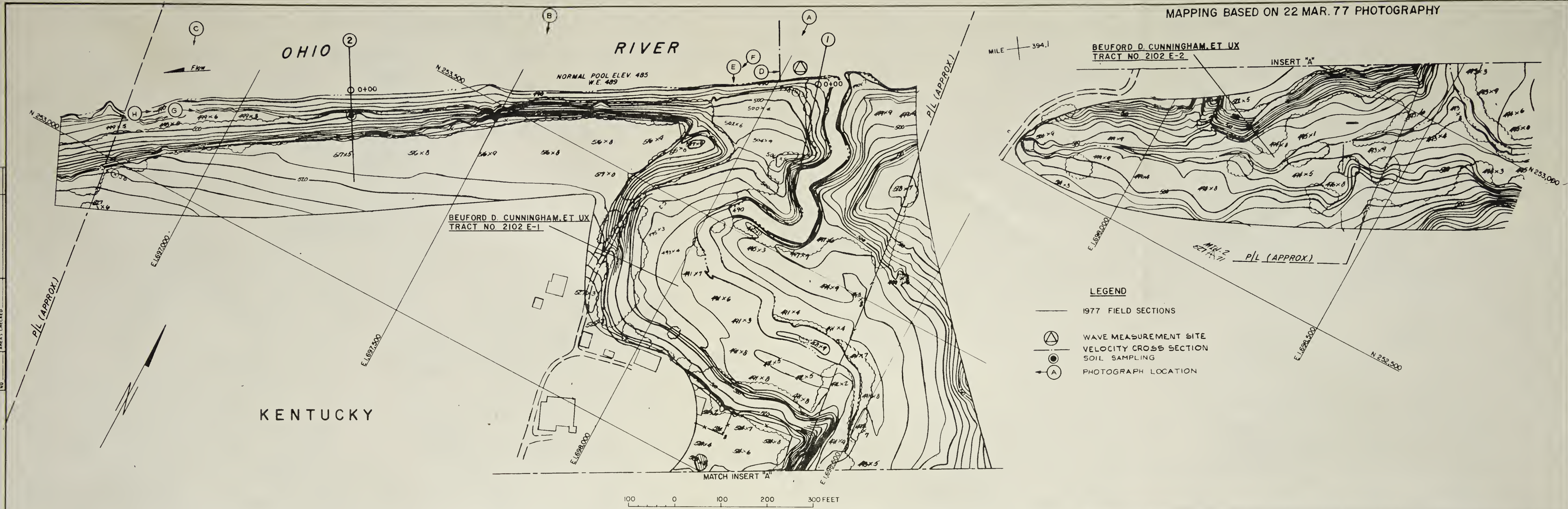
MELDAHL POOL

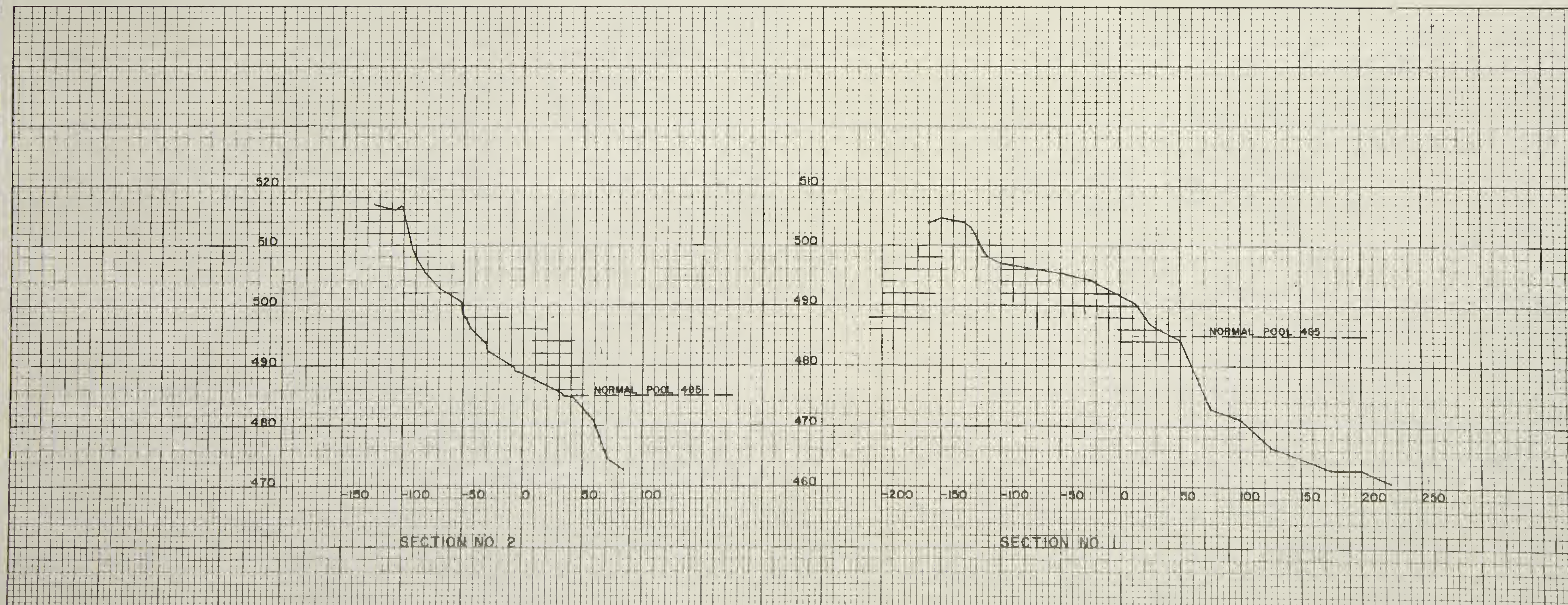
BEUFORD CUNNINGHAM, TRACT NO. 2102E-1 & 2

PLAN AND SECTIONS

MILE 394.5

ORDXE JULY 77





U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY

MELDAHL POOL

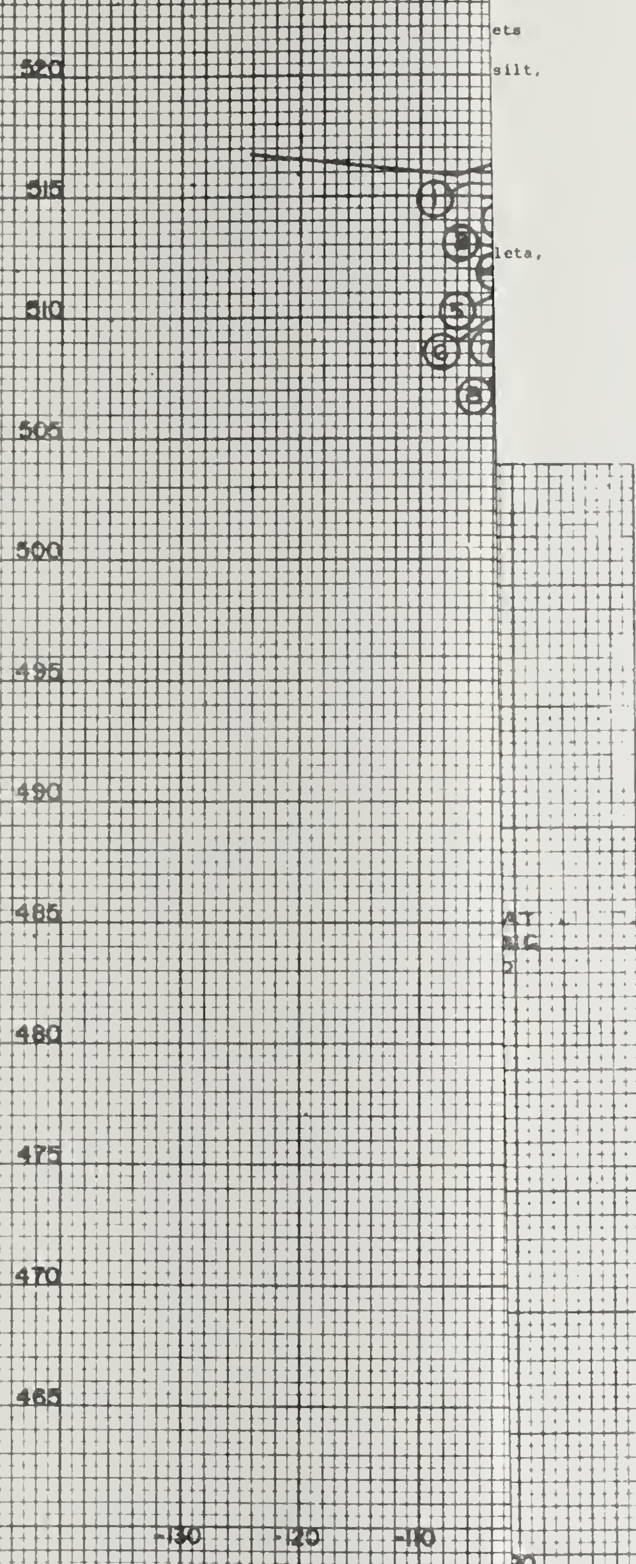
BEUFORD CUNNINGHAM, TRACT NO. 2102E-1 & 2
PLAN AND SECTIONS
MILE 394.5

ORDXE JULY 77

PLATE 37

SHEET 1 OF 2

COUNTY OF	FISCAL YEAR	SHEET NO	TOTAL SHEETS



CUNNINGHAM

11. SILTY SANDY CLAY, brown, few rootlets, increasingly sandy w/depth, moist

12. CLAYEY SANDY SILT, brown, rootlets, w/stringers of silt and sand, moist

13. SILT, gray & SAND, gray-brown, interbedded, many rootlets, moist

14. SILTY SANDY CLAY, gray-brown, slightly organic, many rootlets, moist

15. SILTY CLAY, gray-brown, and SILTY SAND, light brown, finely interbedded

16. SILTY CLAY, gray, organic, highly plastic

17. SAND, light brown, trace silt

18. SANDY SILT, gray, and SILTY SAND, brown, finely interbedded

19. SILTY SAND, mottled light to dark gray-brown, w/sandy silt stringers, many roots & rootlets

20. NO SAMPLE

21. SILTY CLAY, gray, w/dessication cracks & occasional leaf & twig fragments, sand stringers in top 3", damp

22. SAND, light brown

23. SILT NODULES in SILTY SAND matrix

24. SAND, light brown, and SILTY SAND, brown, finely interbedded, few rootlets becoming absent w/depth, dark brown sandy silt stringers bottom half, moist

25. SANDY SILT, dark gray-brown, trace coal fines, w/silty sand stringers, damp

26. SILTY CLAY, dark gray, wet, same as 21., 1" to 4" thick

27. SILTY SAND, brown, wet

28. SILTY SAND, light brown to reddish brown, w/clay stringers & lenses, moist to damp

29. CLAYEY SILT, gray, & SILTY SAND, brown, interbedded

30. SILTY SAND, light brown w/silt stringers

31. SILTY SAND, orange brown, damp

32. SILTY SAND, w/numerous rounded to sub-angular gravels

33. SILTY SAND, brown, wet

FINAL SURVEY		BY	DATE
NOTE BOOK	SURVEYED		
	PLOTTED		
	TEMPLATE		
	AREAS		
NO	AREAS CHECKED		

ORIGINAL SURVEY		BY	DATE
NOTE BOOK	SURVEYED		
	PLOTTED		
	TEMPLATE		
	AREAS		
NO	AREAS CHECKED		

U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

MELDAHL POOL

BEUFORD CUNNINGHAM, TRACT NO. 2102E-1 & 2

SOIL & VEGETATION PROFILE

MILE 394.5

ORDXE JULY 77

DIETZGEN 8-17-70
FORM NO. 8

COUNTY OF	FISCAL YEAR	SHEET NO	TOTAL SHEETS

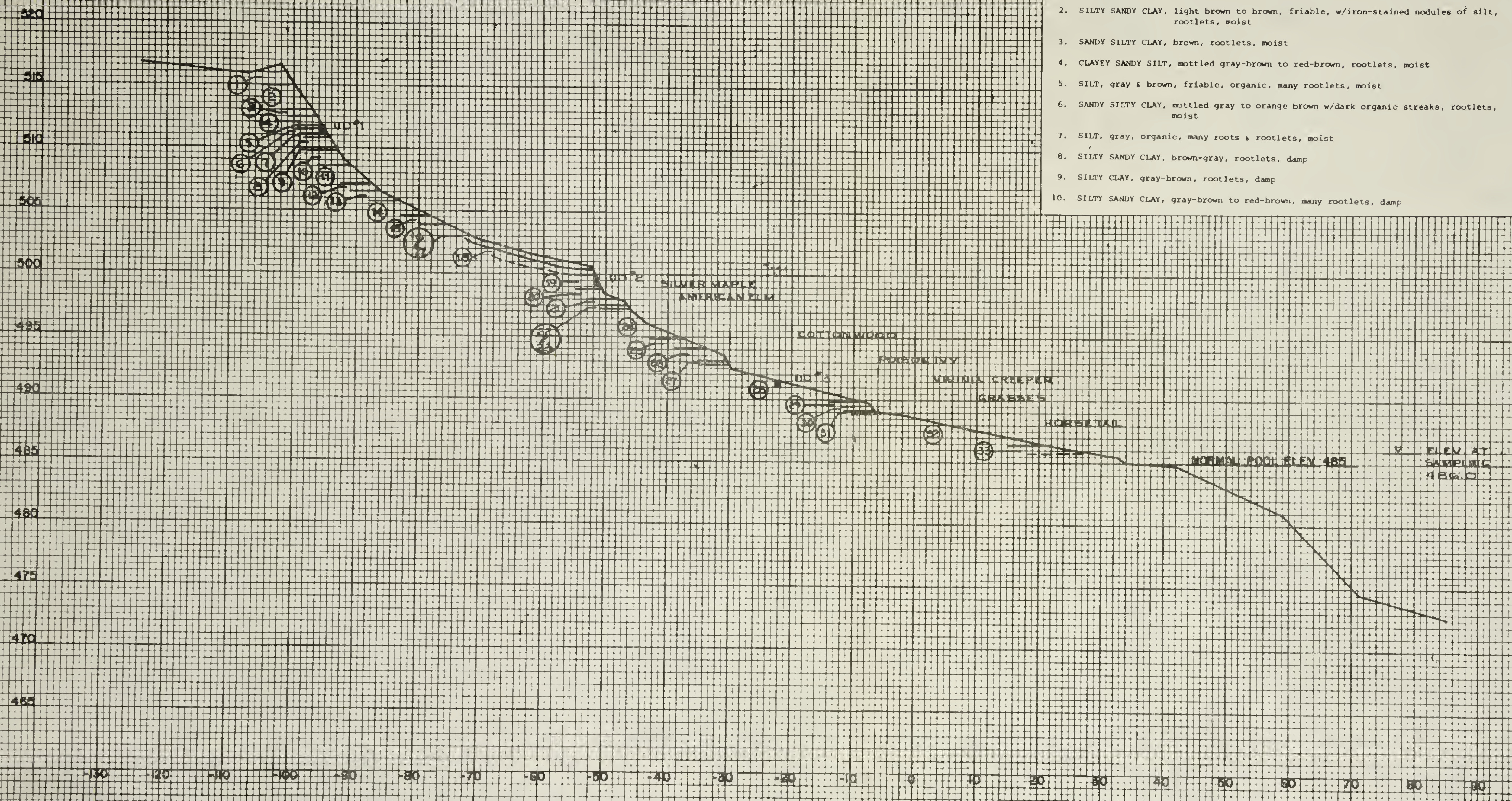
CUNNINGHAM

Tract 2102 E-1 & 2

1. SILTY SANDY CLAY, dark brown, friable, slightly organic, many roots & rootlets
2. SILTY SANDY CLAY, light brown to brown, friable, w/iron-stained nodules of silt, rootlets, moist
3. SANDY SILTY CLAY, brown, rootlets, moist
4. CLAYEY SANDY SILT, mottled gray-brown to red-brown, rootlets, moist
5. SILT, gray & brown, friable, organic, many rootlets, moist
6. SANDY SILTY CLAY, mottled gray to orange brown w/dark organic streaks, rootlets, moist
7. SILT, gray, organic, many roots & rootlets, moist
8. SILTY SANDY CLAY, brown-gray, rootlets, damp
9. SILTY CLAY, gray-brown, rootlets, damp
10. SILTY SANDY CLAY, gray-brown to red-brown, many rootlets, damp

CUNNINGHAM

11. SILTY SANDY CLAY, brown, few rootlets, increasingly sandy w/depth, moist
12. CLAYEY SANDY SILT, brown, rootlets, w/stringers of silt and sand, moist
13. SILT, gray & SAND, gray-brown, interbedded, many rootlets, moist
14. SILTY SANDY CLAY, gray-brown, slightly organic, many rootlets, moist
15. SILTY CLAY, gray-brown, and SILTY SAND, light brown, finely interbedded
16. SILTY CLAY, gray, organic, highly plastic
17. SAND, light brown, trace silt
18. SANDY SILT, gray, and SILTY SAND, brown, finely interbedded
19. SILTY SAND, mottled light to dark gray-brown, w/sandy silt stringers, many roots & rootlets
20. NO SAMPLE
21. SILTY CLAY, gray, w/dessication cracks & occasional leaf & twig fragments, sand stringers in top 3", damp
22. SAND, light brown
23. SILT NODULES in SILTY SAND matrix
24. SAND, light brown, and SILTY SAND, brown, finely interbedded, few rootlets becoming absent w/depth, dark brown sandy silt stringers bottom half, moist
25. SANDY SILT, dark gray-brown, trace coal fines, w/silty sand stringers, damp
26. SILTY CLAY, dark gray, wet, same as 21., 1" to 4" thick
27. SILTY SAND, brown, wet
28. SILTY SAND, light brown to reddish brown, w/clay stringers & lenses, moist to damp
29. CLAYEY SILT, gray, & SILTY SAND, brown, interbedded
30. SILTY SAND, light brown w/silt stringers
31. SILTY SAND, orange brown, damp
32. SILTY SAND, w/numerous rounded to sub-angular gravels
33. SILTY SAND, brown, wet



SECTION NO. 2 (TRACT NO. 2102E-1)
1977 FIELD SECTIONS

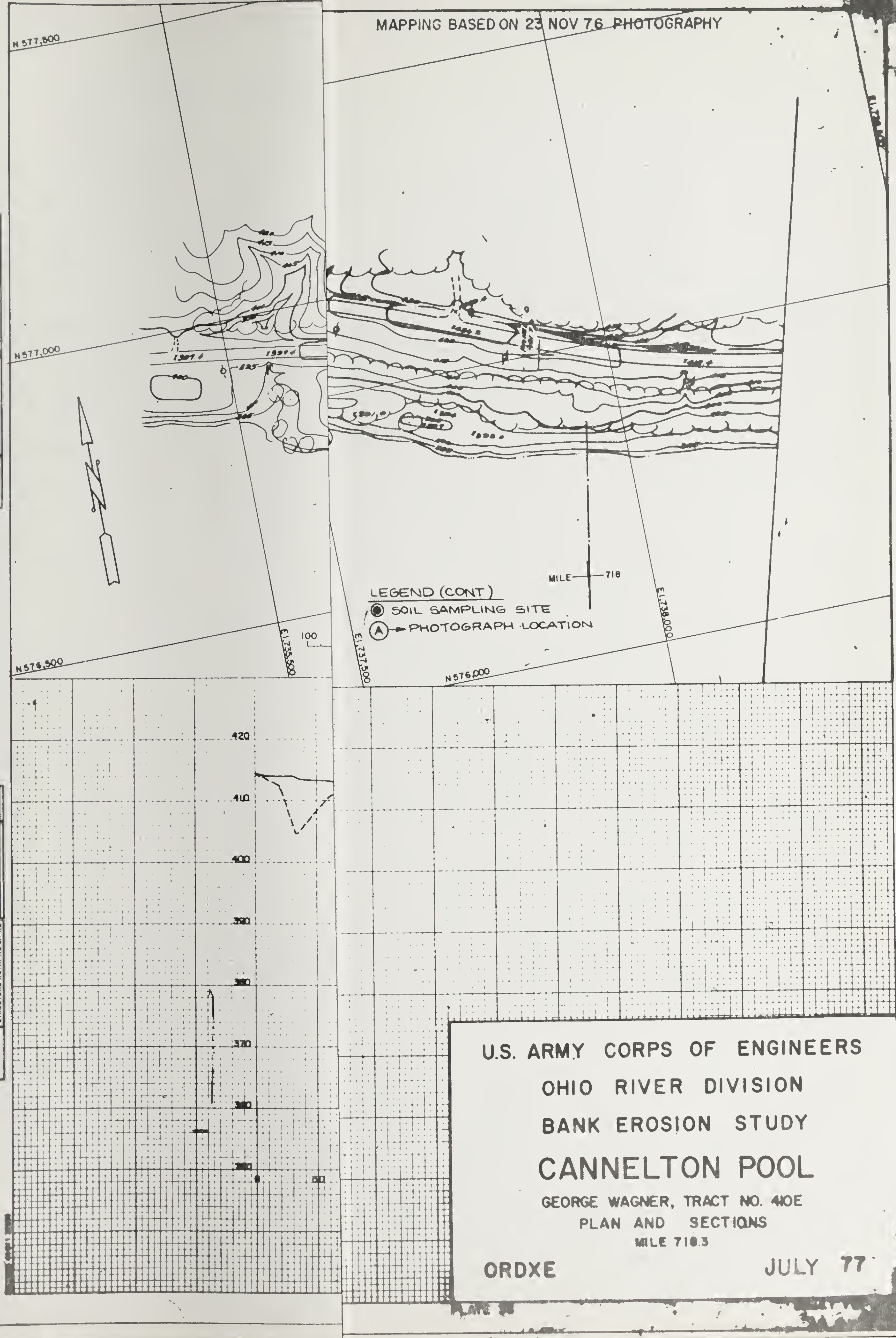
U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY

MELDAHL POOL

BEUFORD CUNNINGHAM, TRACT NO. 2102E-1 & 2
SOIL & VEGETATION PROFILE
MILE 394.5

ORDXE JULY 77

DIETZGEN 8-17-70
FORM NO. 8



U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

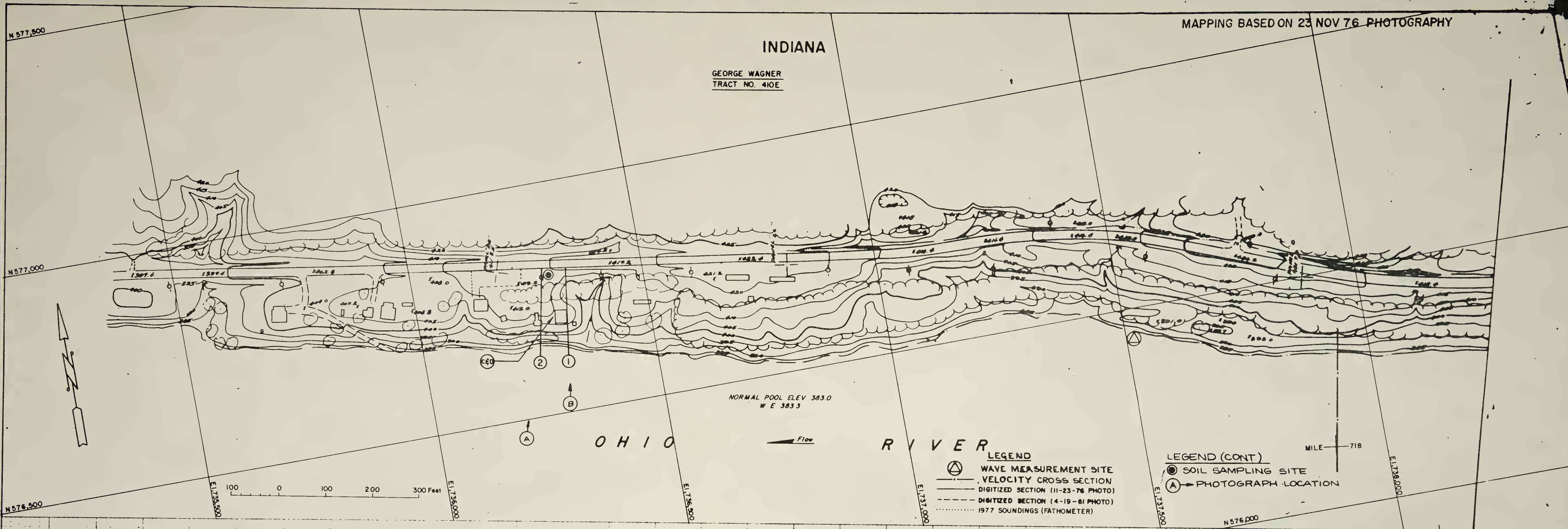
CANNELTON POOL

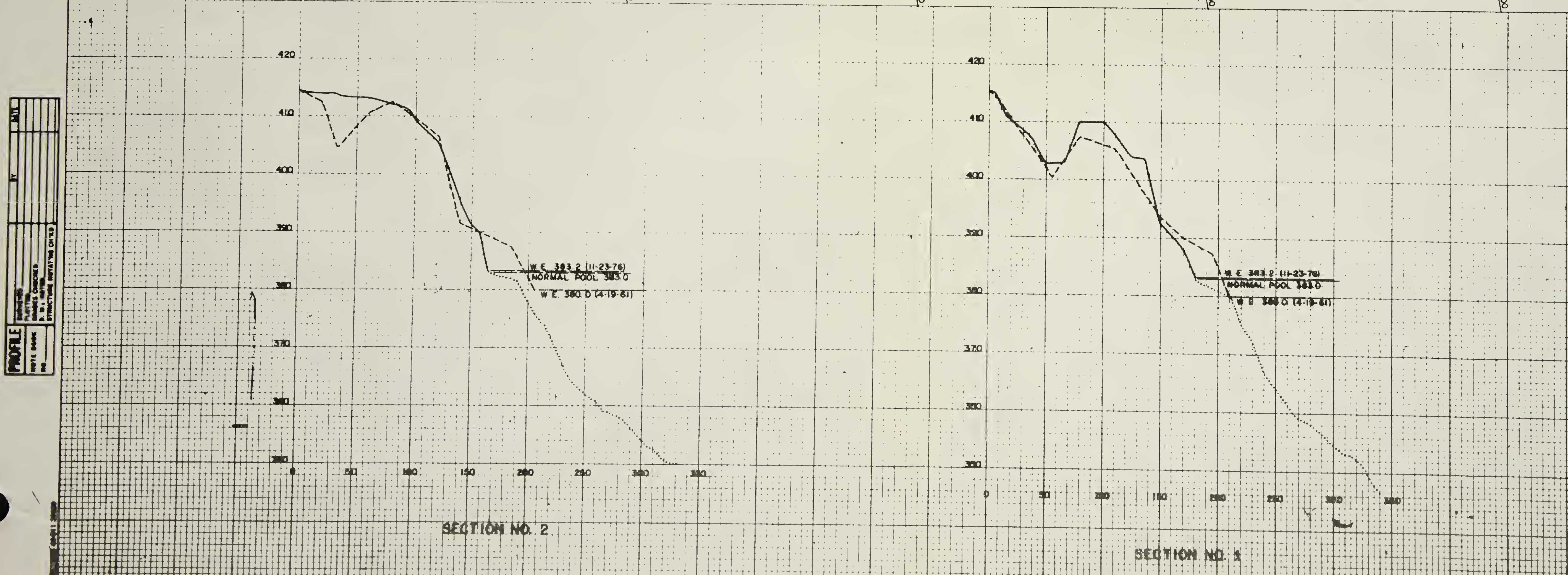
GEORGE WAGNER, TRACT NO. 410E

PLAN AND SECTIONS

MILE 718.3

ORDXE JULY 77





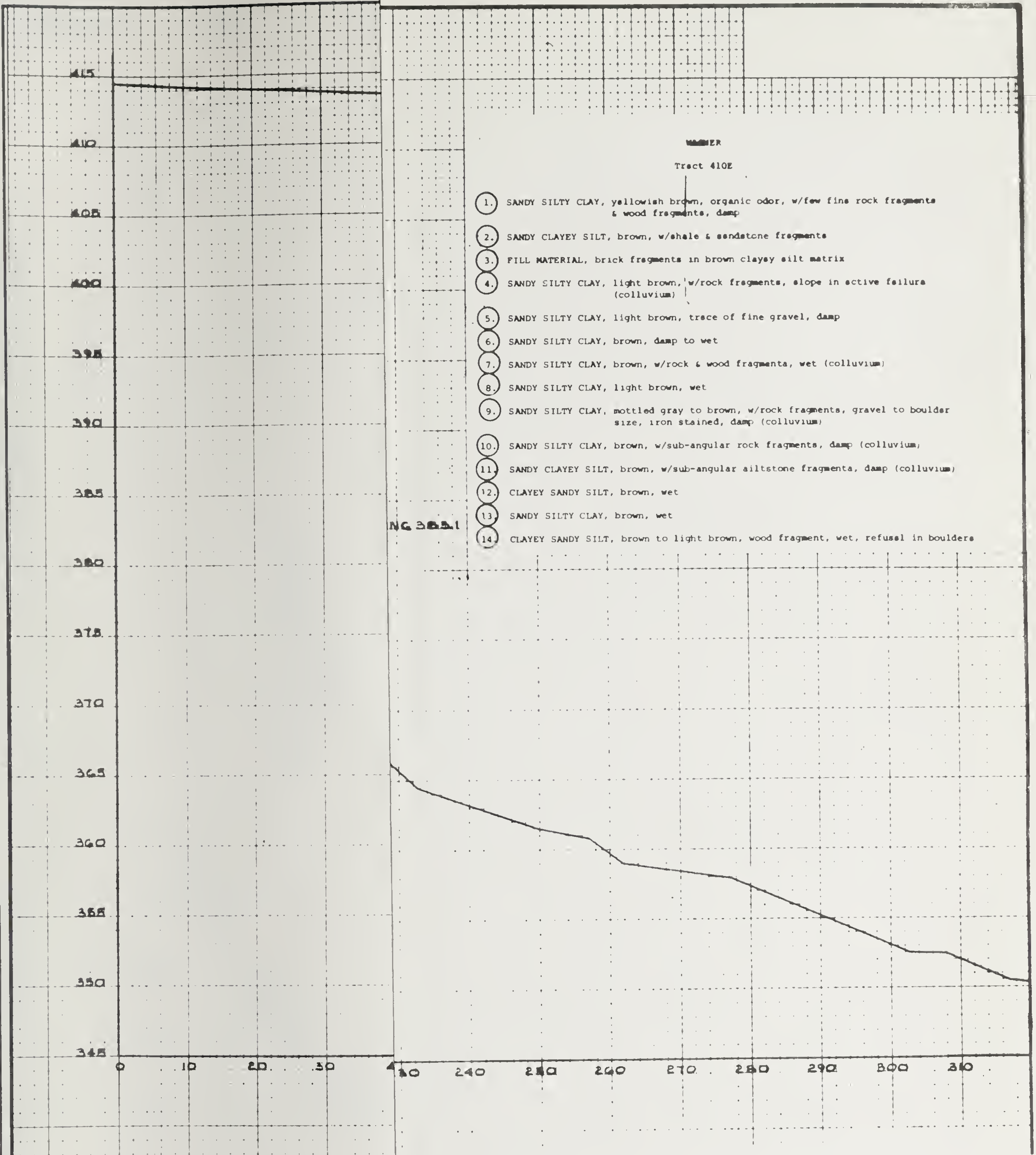
U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY

CANNELTON POOL

GEORGE WAGNER, TRACT NO. 410E
PLAN AND SECTIONS
MILE 718.3

ORDXE

JULY 77



U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

CANNELTON POOL

GEORGE WAGNER, TRACT NO. 410E

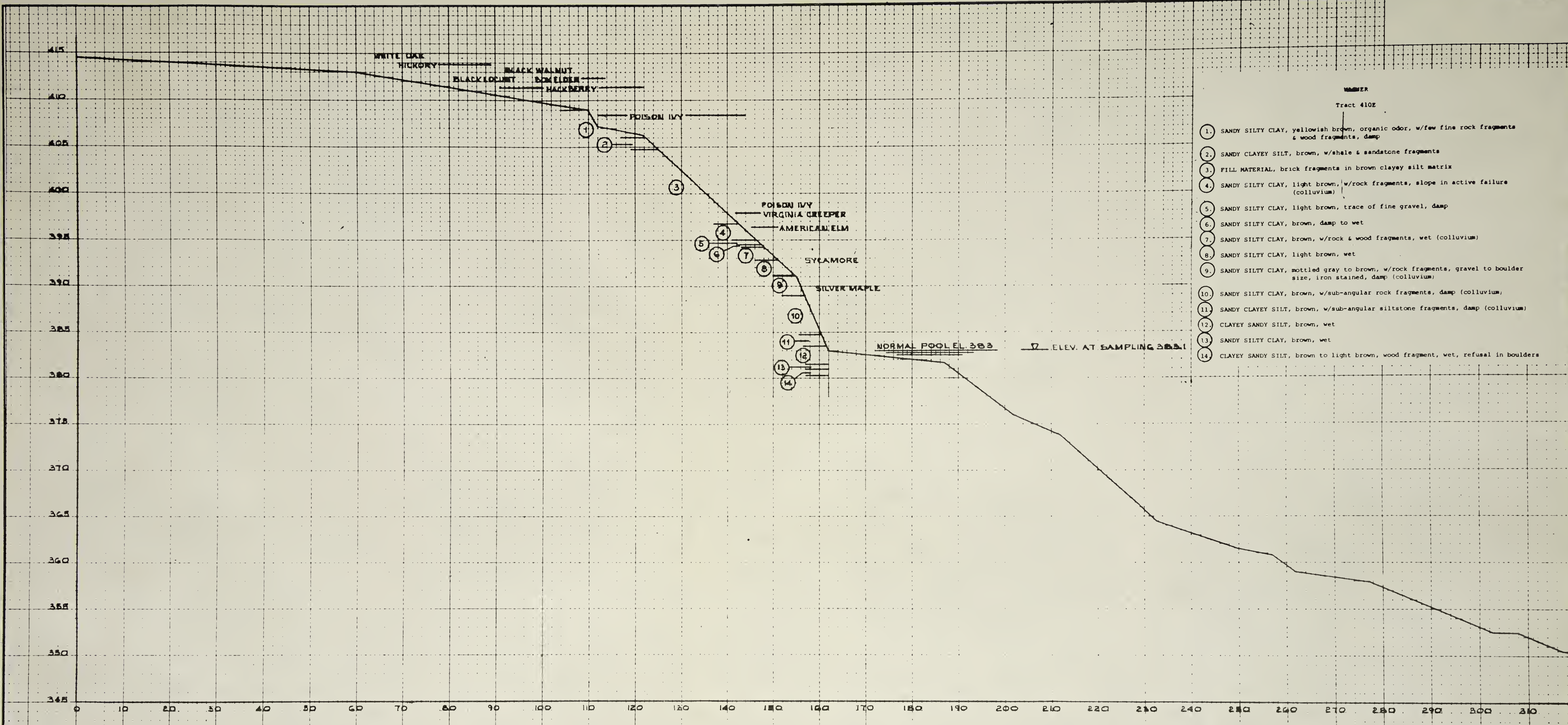
SOIL & VEGETATION PROFILE

MILE 718.3

ORDXE JULY 77

PLATE 38

SHEET 2 OF 2



U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY

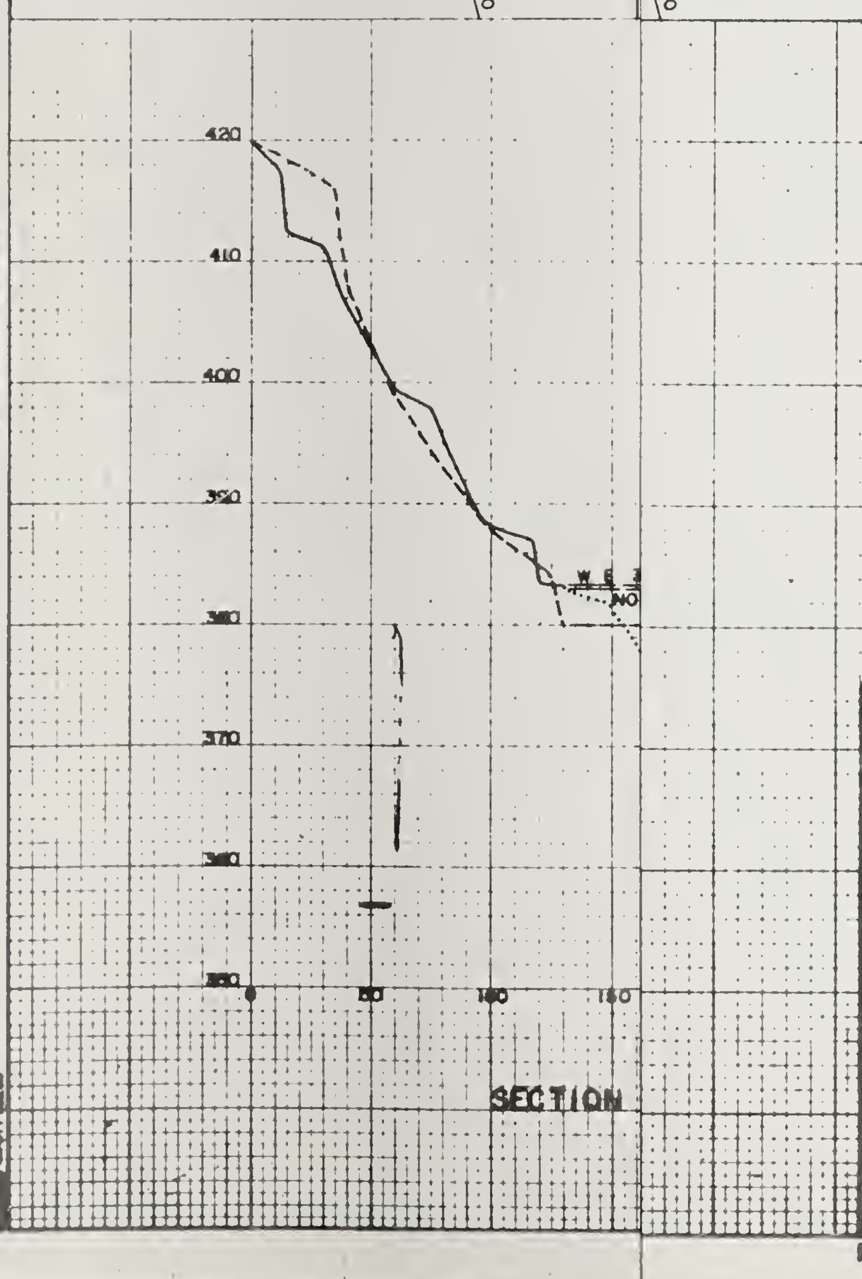
CANNELTON POOL

GEORGE WAGNER, TRACT NO. 410E
SOIL & VEGETATION PROFILE
MILE 718.3

ORDXE JULY 77

PLATE 38

SHEET 2 OF 2



U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

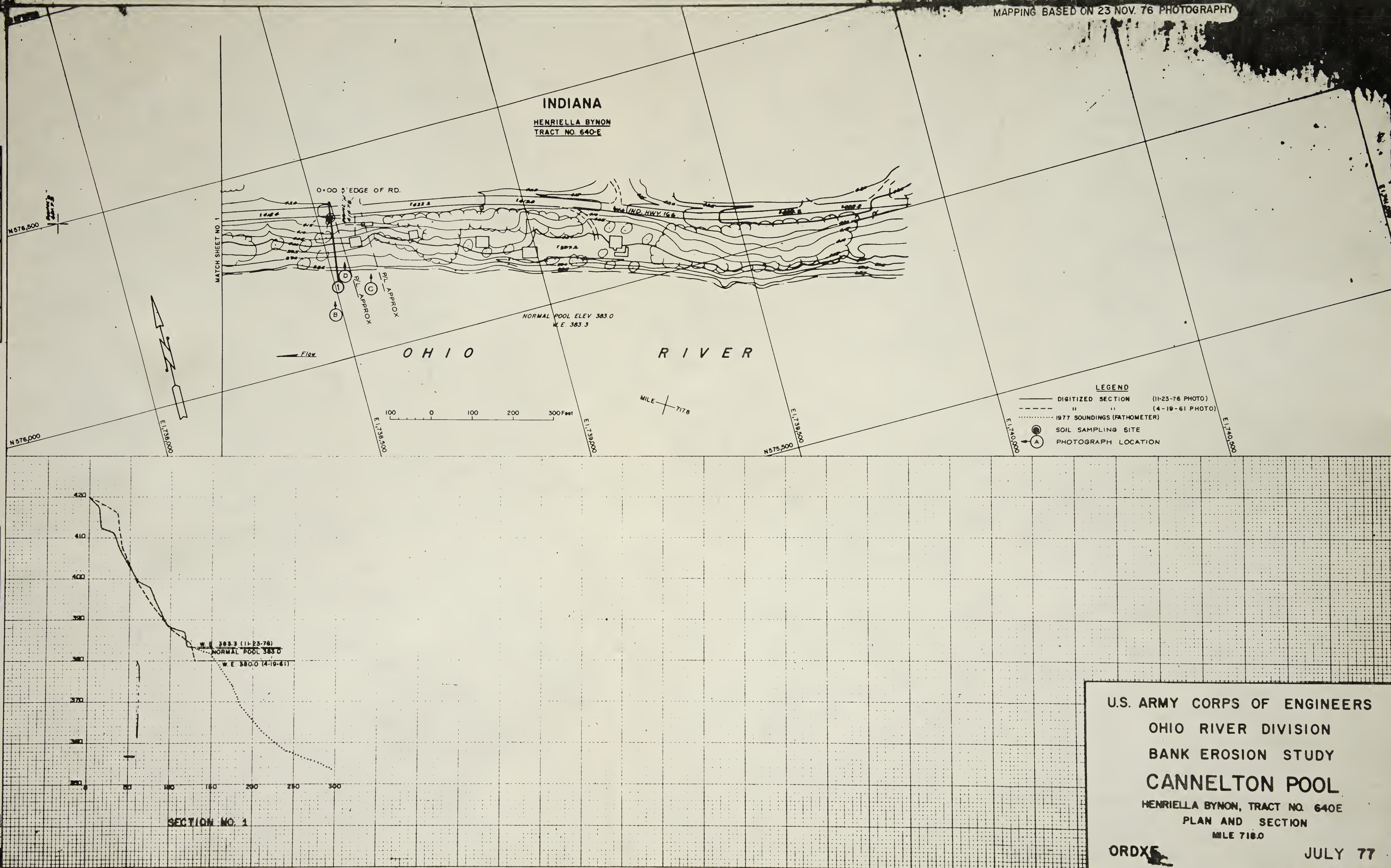
CANNELTON POOL

HENRIELLA BYNON, TRACT NO. 640E

PLAN AND SECTION

MILE 718.0

ORDXE JULY 77



U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

CANNELTON POOL

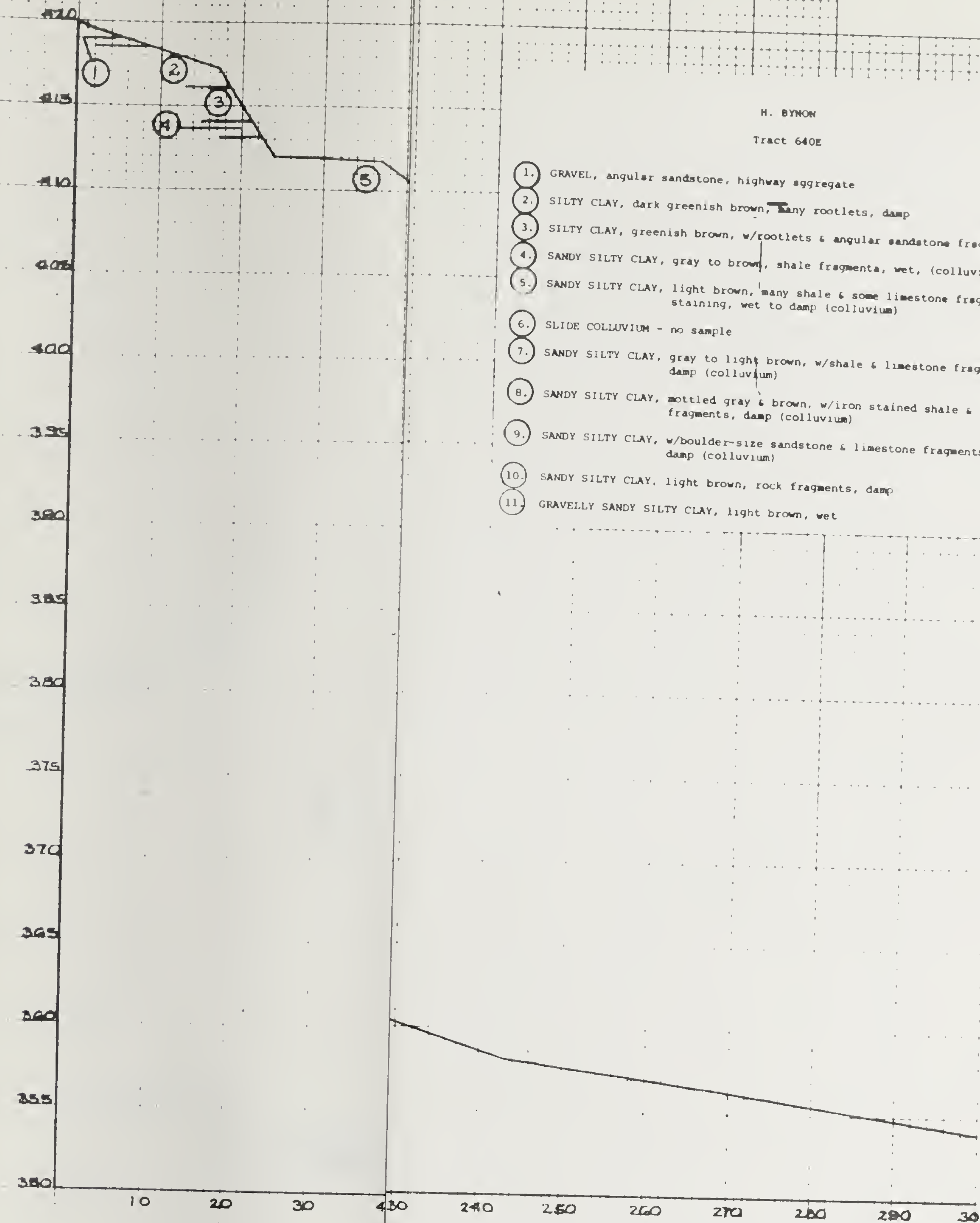
HENRIELLA BYNON, TRACT NO. 640E

PLAN AND SECTION

MILE 718.0

ORDXE JULY 77

PLATE 39



H. BYNON

Tract 640E

1. GRAVEL, angular sandstone, highway aggregate
2. SILTY CLAY, dark greenish brown, many rootlets, damp
3. SILTY CLAY, greenish brown, w/rootlets & angular sandstone fragments, damp
4. SANDY SILTY CLAY, gray to brown, shale fragments, wet, (colluvium)
5. SANDY SILTY CLAY, light brown, many shale & some limestone fragments, iron staining, wet to damp (colluvium)
6. SLIDE COLLUVIUM - no sample
7. SANDY SILTY CLAY, gray to light brown, w/shale & limestone fragments & wood, damp (colluvium)
8. SANDY SILTY CLAY, mottled gray & brown, w/iron stained shale & limestone fragments, damp (colluvium)
9. SANDY SILTY CLAY, w/boulder-size sandstone & limestone fragments, iron staining, damp (colluvium)
10. SANDY SILTY CLAY, light brown, rock fragments, damp
11. GRAVELLY SANDY SILTY CLAY, light brown, wet

FINAL SURVEY

ORIGINAL SURVEY

U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

CANNELTON POOL

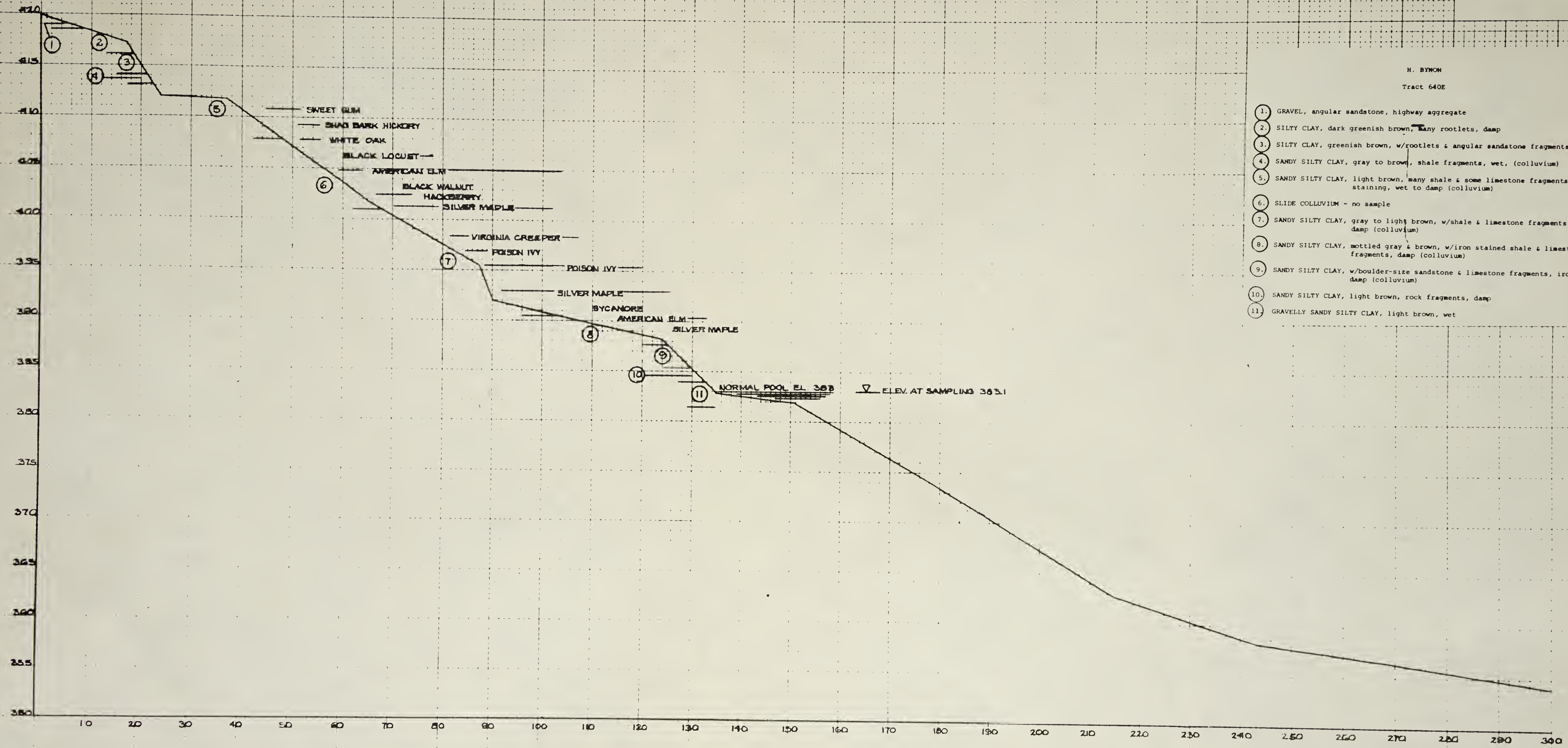
HENRIELLA BYNON, TRACT NO. 640E

SOIL & VEGETATION PROFILE

MILE 718

ORDXE JULY 77

PLATE 39 SHEET 2 OF 2



SECTION NO. 1

H. BYNON

Tract 640E

1. GRAVEL, angular sandstone, highway aggregate
2. SILTY CLAY, dark greenish brown, many rootlets, damp
3. SILTY CLAY, greenish brown, w/rootlets & angular sandstone fragments, damp
4. SANDY SILTY CLAY, gray to brown, shale fragments, wet, (colluvium)
5. SANDY SILTY CLAY, light brown, many shale & some limestone fragments, iron staining, wet to damp (colluvium)
6. SLIDE COLLUVIUM - no sample
7. SANDY SILTY CLAY, gray to light brown, w/shale & limestone fragments & wood, damp (colluvium)
8. SANDY SILTY CLAY, mottled gray & brown, w/iron stained shale & limestone fragments, damp (colluvium)
9. SANDY SILTY CLAY, w/boulder-size sandstone & limestone fragments, iron staining, damp (colluvium)
10. SANDY SILTY CLAY, light brown, rock fragments, damp
11. GRAVELLY SANDY SILTY CLAY, light brown, wet

FINAL SURVEY

ORIGINAL SURVEY

U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY

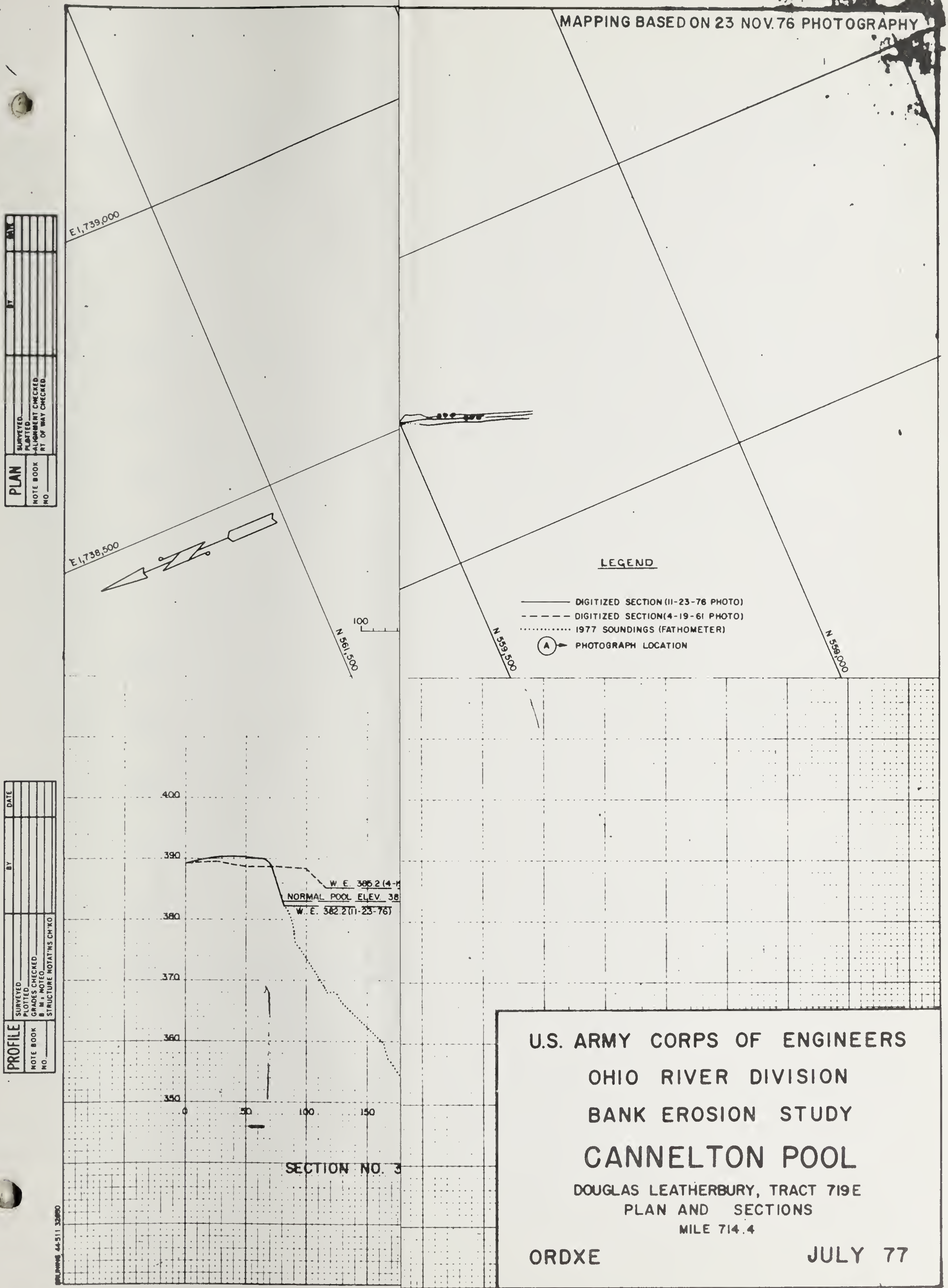
CANNELTON POOL

HENRIELLA BYNON, TRACT NO. 640E
SOIL & VEGETATION PROFILE
MILE 718

ORDXE JULY 77

PLATE 39

SHEET 2 OF 2



U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

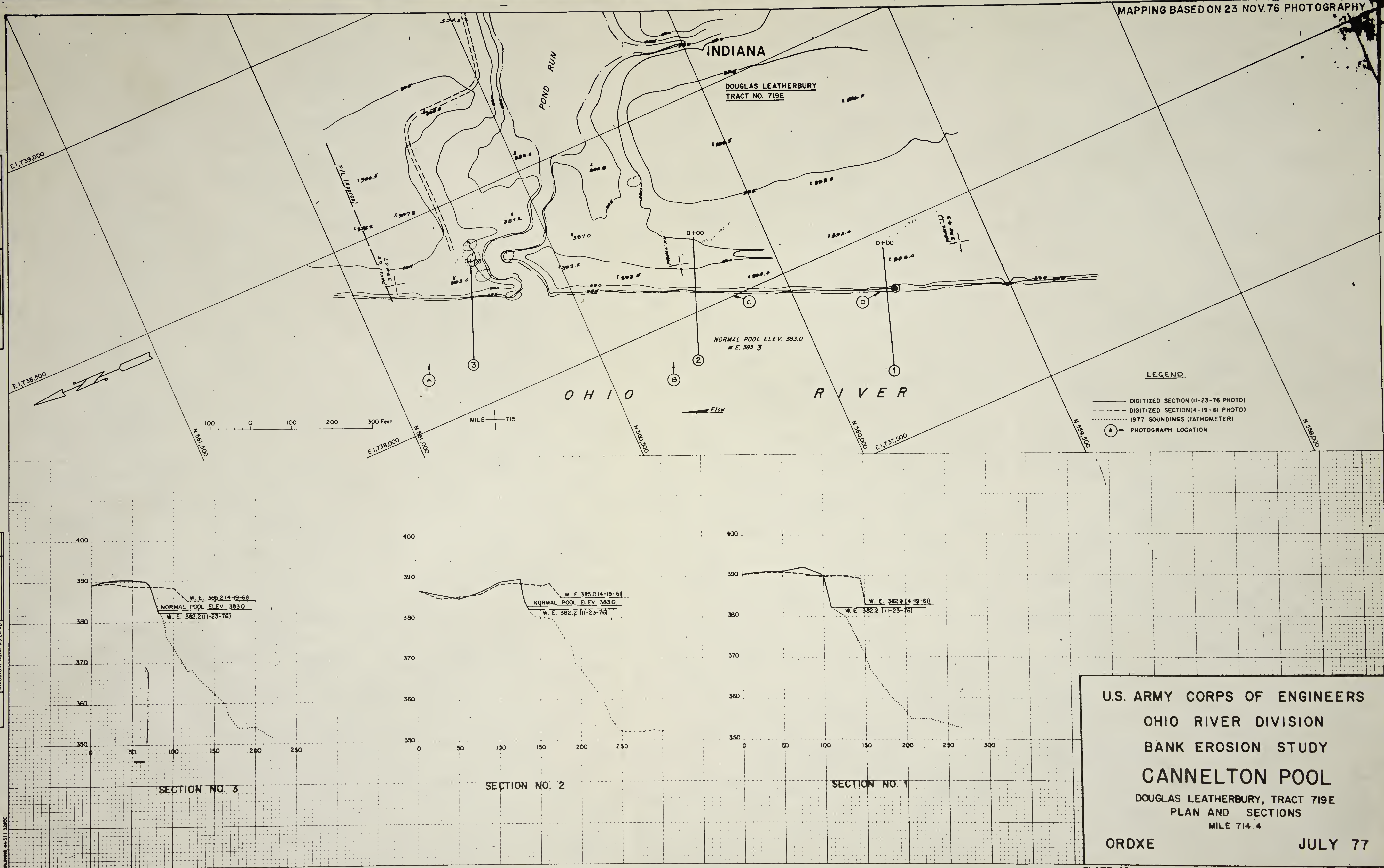
CANNELTON POOL

DOUGLAS LEATHERBURY, TRACT 719E

PLAN AND SECTIONS

MILE 714.4

ORDXE JULY 77



U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY

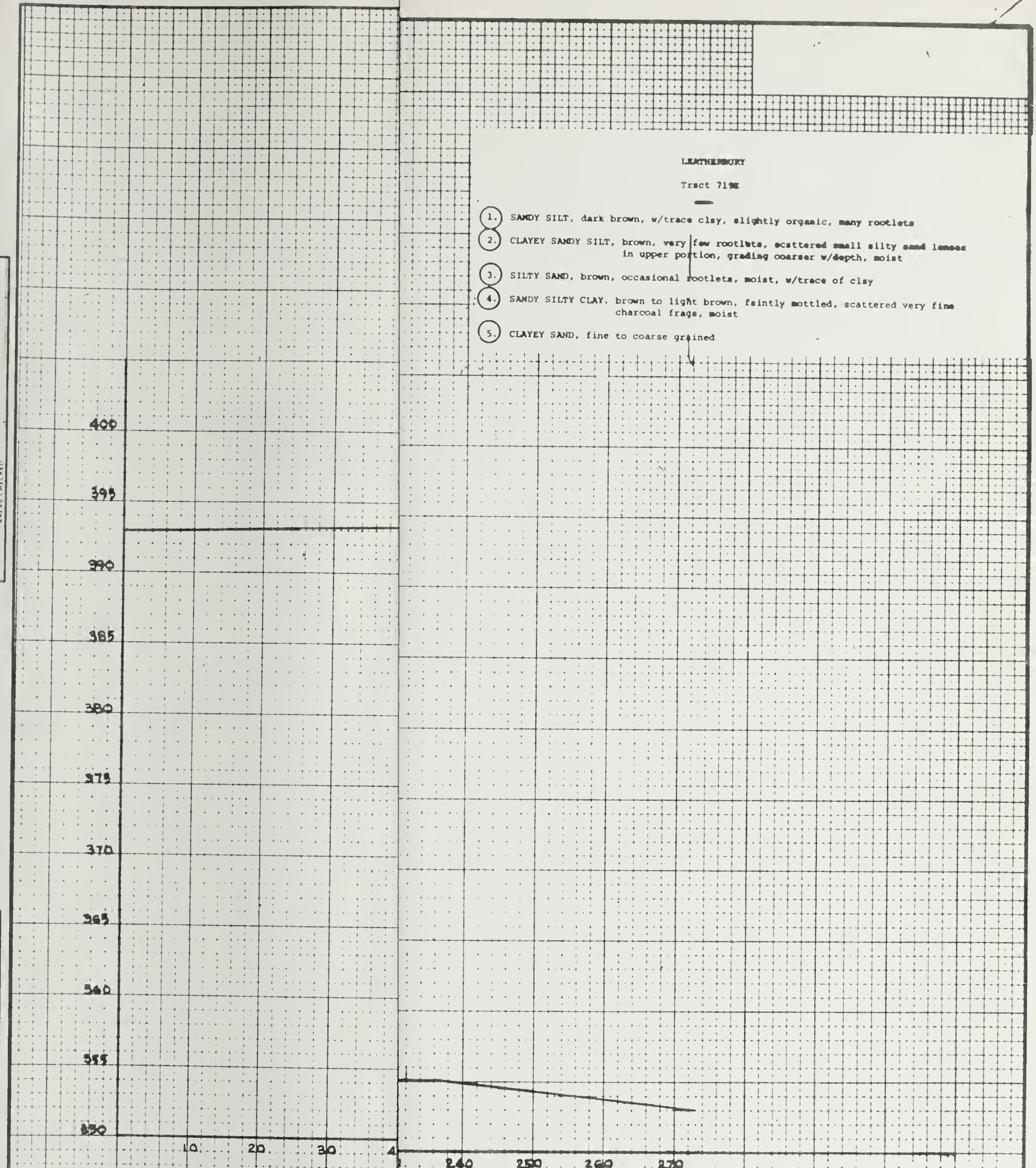
CANNELTON POOL

DOUGLAS LEATHERBURY, TRACT 719E
PLAN AND SECTIONS
MILE 714.4

ORDXE JULY 77

PLATE 40

SHEET 1 OF 2



U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

CANNELTON POOL

DOUGLAS LEATHERBURY, TRACT 719E

SOIL & VEGETATION PROFILE

MILE 714.4

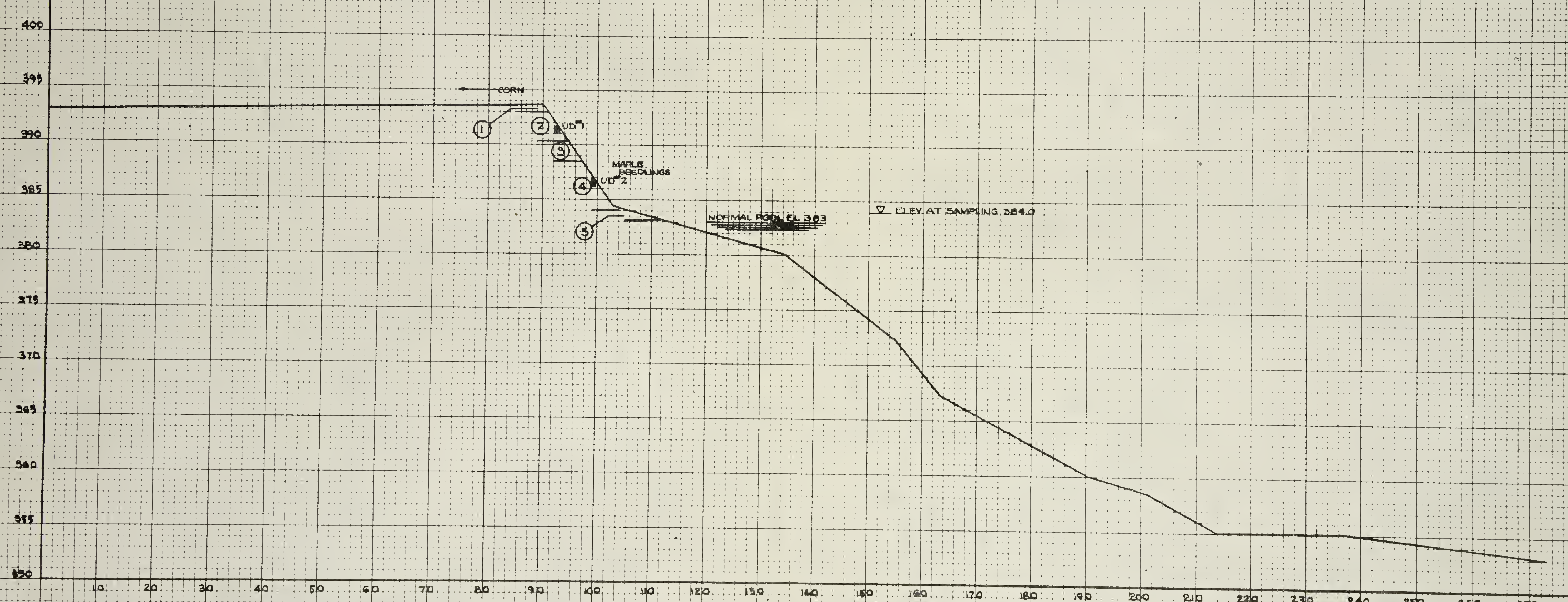
ORDXE JULY 77

PLATE 40 SHEET 2 OF 2

LEATHERBURY

Tract 719E

1. SANDY SILT, dark brown, w/trace clay, slightly organic, many rootlets
2. CLAYEY SANDY SILT, brown, very few rootlets, scattered small silty sand lenses in upper portion, grading coarser w/depth, moist
3. SILTY SAND, brown, occasional rootlets, moist, w/trace of clay
4. SANDY SILTY CLAY, brown to light brown, faintly mottled, scattered very fine charcoal frags, moist
5. CLAYEY SAND, fine to coarse grained



SECTION NO.1

FINAL SURVEY

ORIGINAL SURVEY

U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

CANNELTON POOL

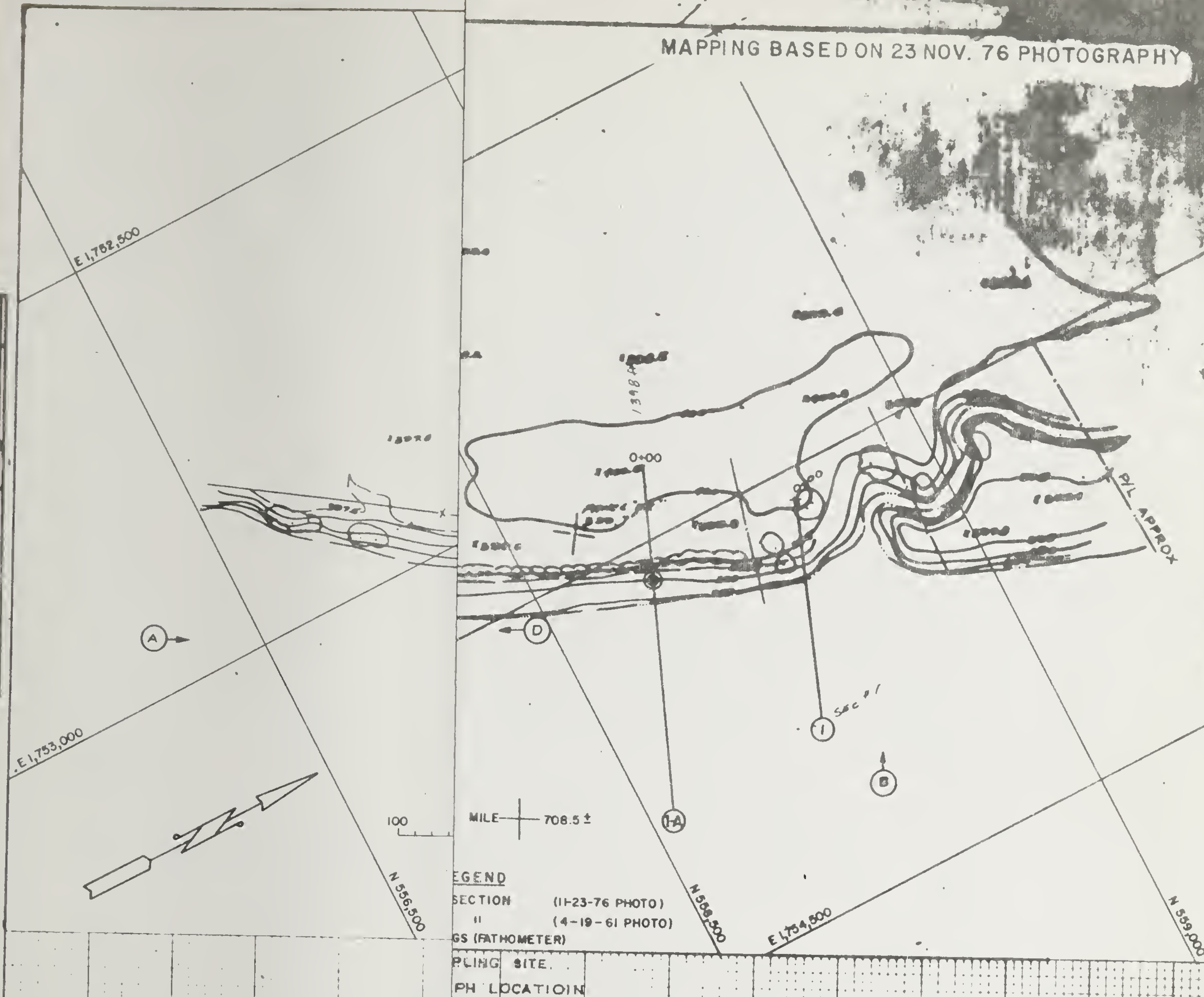
DOUGLAS LEATHERBURY, TRACT 719E

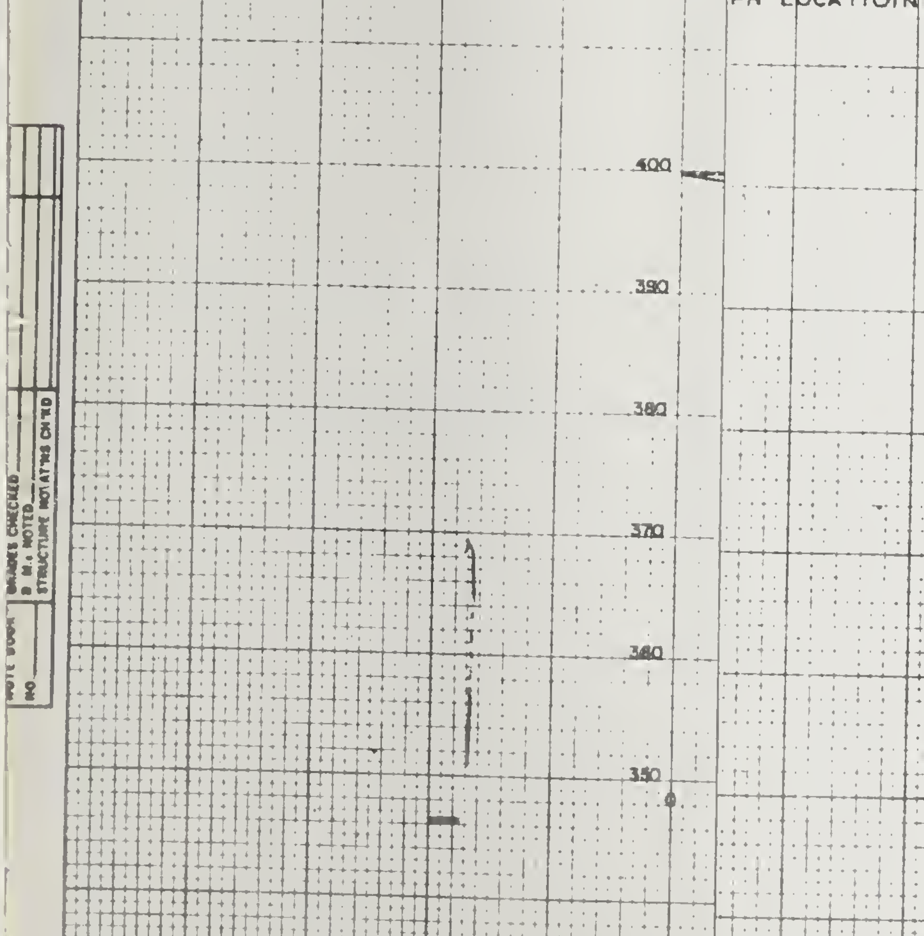
SOIL & VEGETATION PROFILE

MILE 714.4

ORDXE

JULY 77





U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

CANNELTON POOL

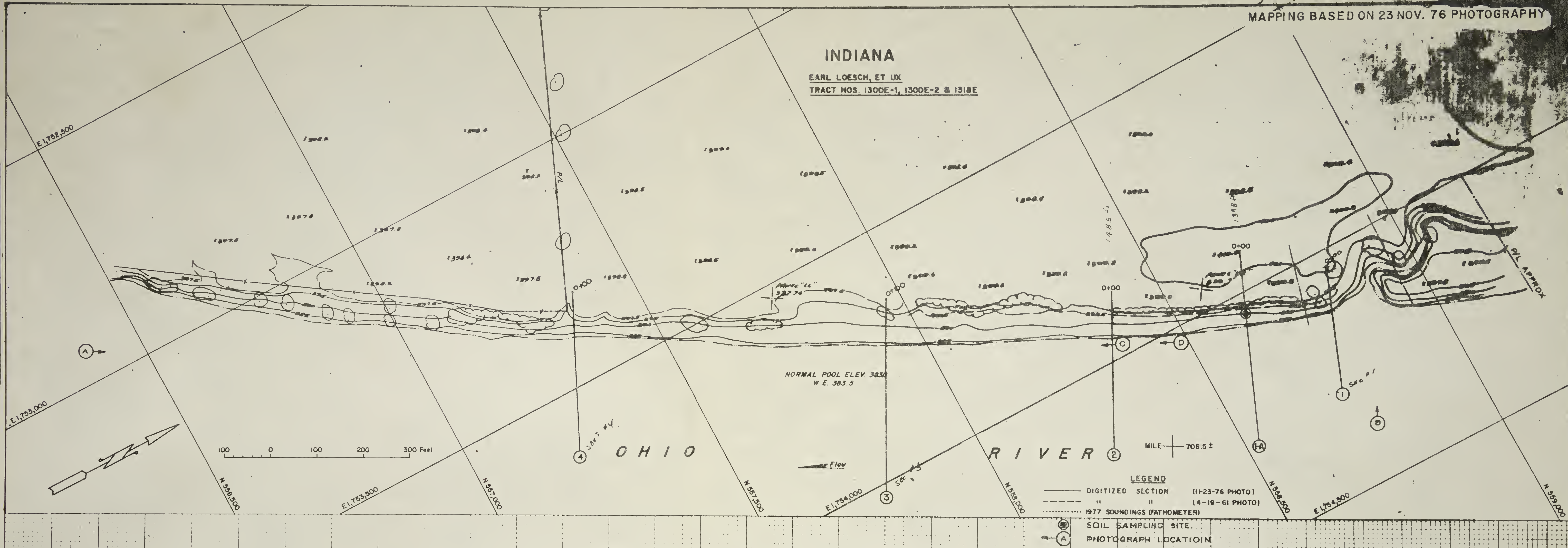
EARL LOESCH, ET UX

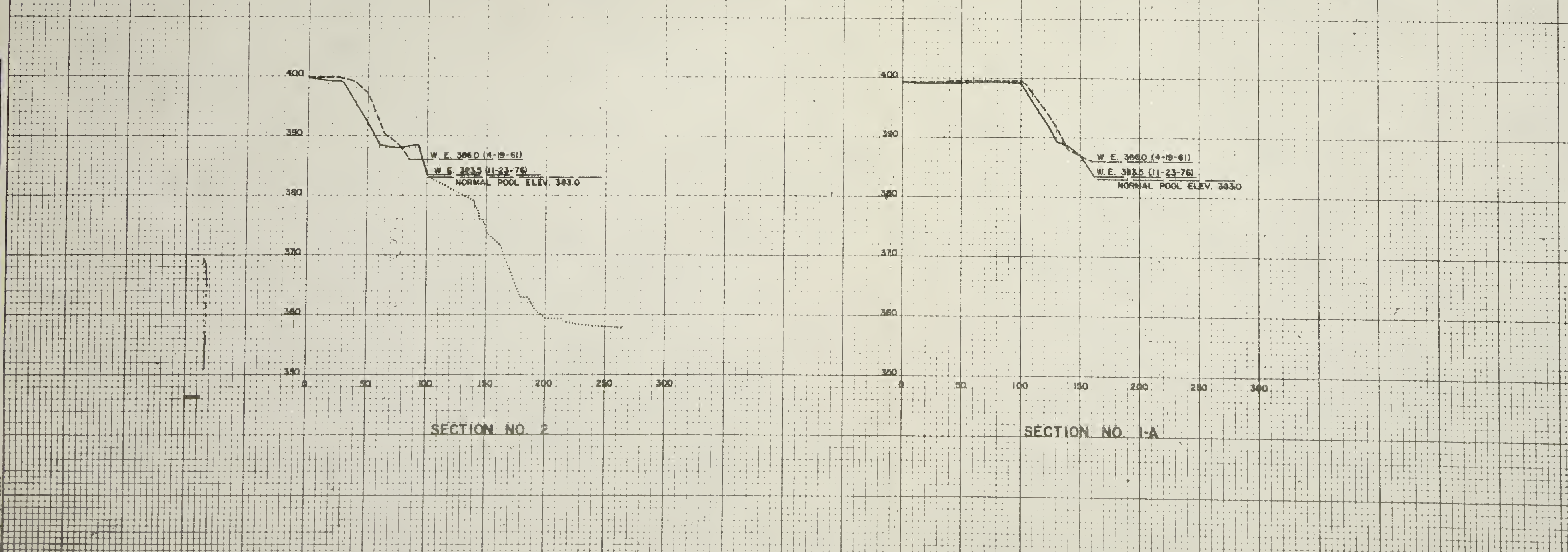
TRACTS 1300E-1, 1300E-2 & 1316E

MILE 706.2

ORDXE JULY 77

MAPPING BASED ON 23 NOV. 76 PHOTOGRAPHY





U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY

CANNELTON POOL

EARL LOESCH, ET UX
TRACTS 1300E-1, 1300E-2 & 1318E
MILE 708.2

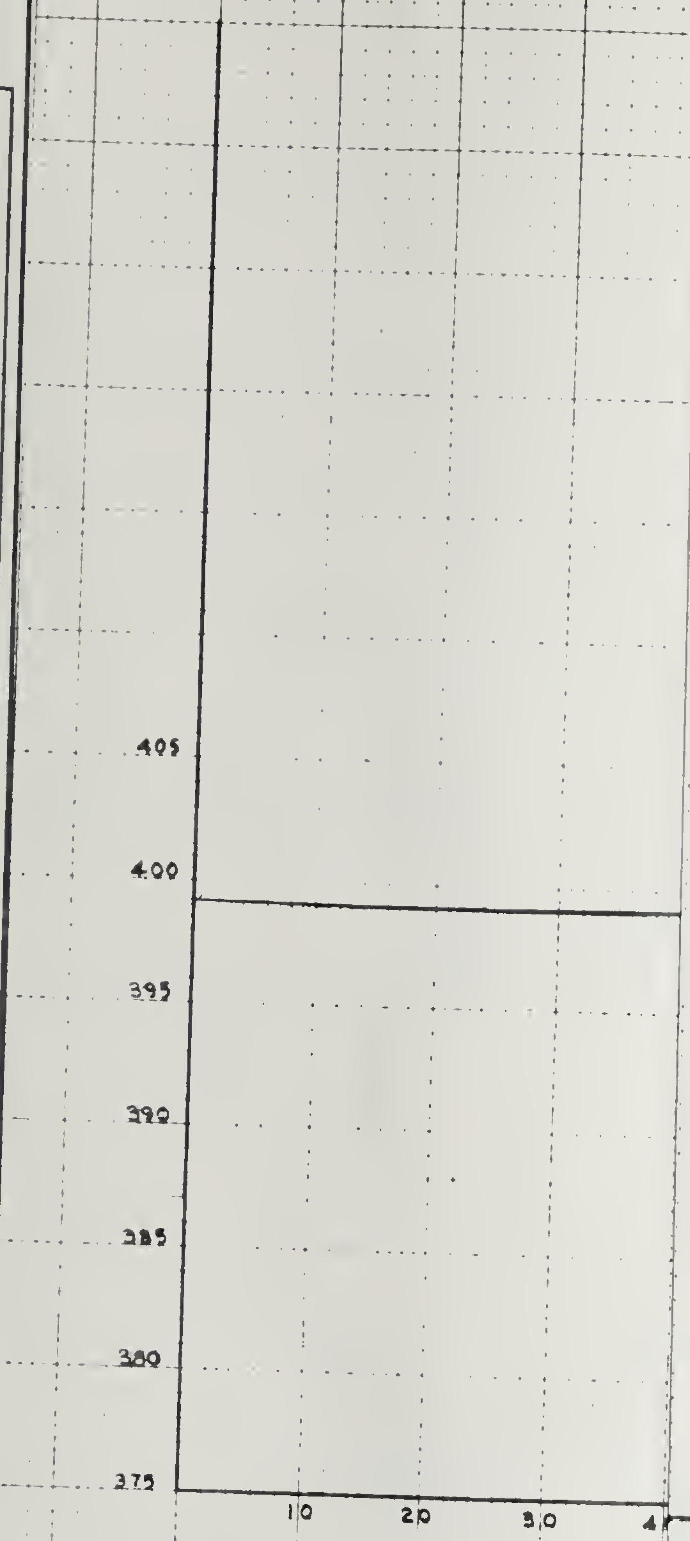
ORDXE JULY 77

PLATE 41

LOESCH

Tracts 1300E-1 & 2, 1318E

1. CLAYEY SANDY SILT, dark brown, slightly organic, rootlets, moist
2. SANDY CLAYEY SILT, dark brown to brown, few rootlets, moist
3. SANDY SILTY CLAY, dark brown, zone of many rootlets in mid-layer, 1/4" charcoal frag near bottom
4. SANDY SILTY CLAY, brown to dark brown, many rootlets, decayed leaf frags, moist
5. SILTY SANDY CLAY, grayish brown to light brown, few rootlets, moist
6. SANDY SILTY CLAY, brown, few rootlets, moist
7. NO SAMPLE
8. SANDY SILTY CLAY, dark brown to brown, rootlets, moist
9. NO SAMPLE
10. SANDY CLAYEY SILT, dark brown, w/sand lenses & seams, many rootlets, moist
11. SILTY SAND, brown, w/some dark brown clay & silt seams & lenses, few rootlets, fine charcoal frags
12. SANDY SILT, brown, w/some clay, light brown sand stringers, scattered fine charcoal frags, damp
13. SILTY CLAY, brown, w/trace of fine sand



FINAL SURVEY

ORIGINAL SURVEY

U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

CANNELTON POOL

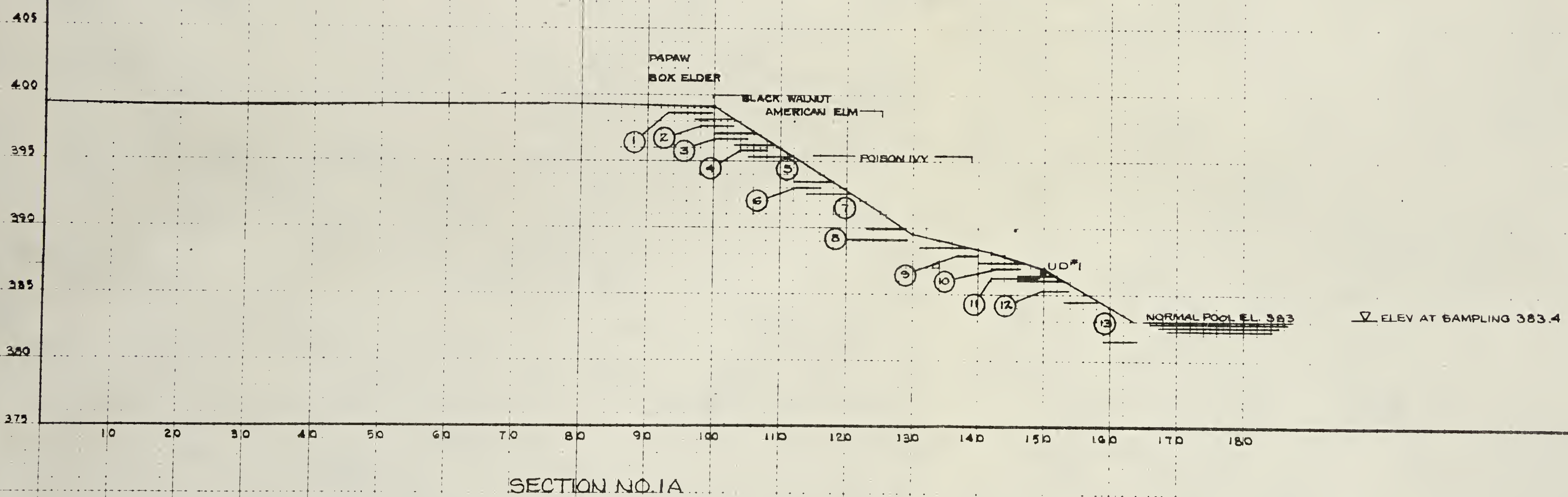
EARL LOESCH, ET UX

TRACTS 1300E-1, 1300E-2 & 1318E

SOIL & VEGETATION PROFILE

MILE 708.2

ORDXE JULY 77



LOESCH

Tracts 1300E-1 & 2, 1318E

1. CLAYEY SANDY SILT, dark brown, slightly organic, rootlets, moist
2. SANDY CLAYEY SILT, dark brown to brown, few rootlets, moist
3. SANDY SILTY CLAY, dark brown, zone of many rootlets in mid-layer, 1/4" charcoal frag near bottom
4. SANDY SILTY CLAY, brown to dark brown, many rootlets, decayed leaf frags, moist
5. SILTY SANDY CLAY, grayish brown to light brown, few rootlets, moist
6. SANDY SILTY CLAY, brown, few rootlets, moist
7. NO SAMPLE
8. SANDY SILTY CLAY, dark brown to brown, rootlets, moist
9. NO SAMPLE
10. SANDY CLAYEY SILT, dark brown, w/sand lenses & seams, many rootlets, moist
11. SILTY SAND, brown, w/some dark brown clay & silt seams & lenses, few rootlets, fine charcoal frags
12. SANDY SILT, brown, w/some clay, light brown sand stringers, scattered fine charcoal frags, damp
13. SILTY CLAY, brown, w/trace of fine sand

U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

CANNELTON POOL

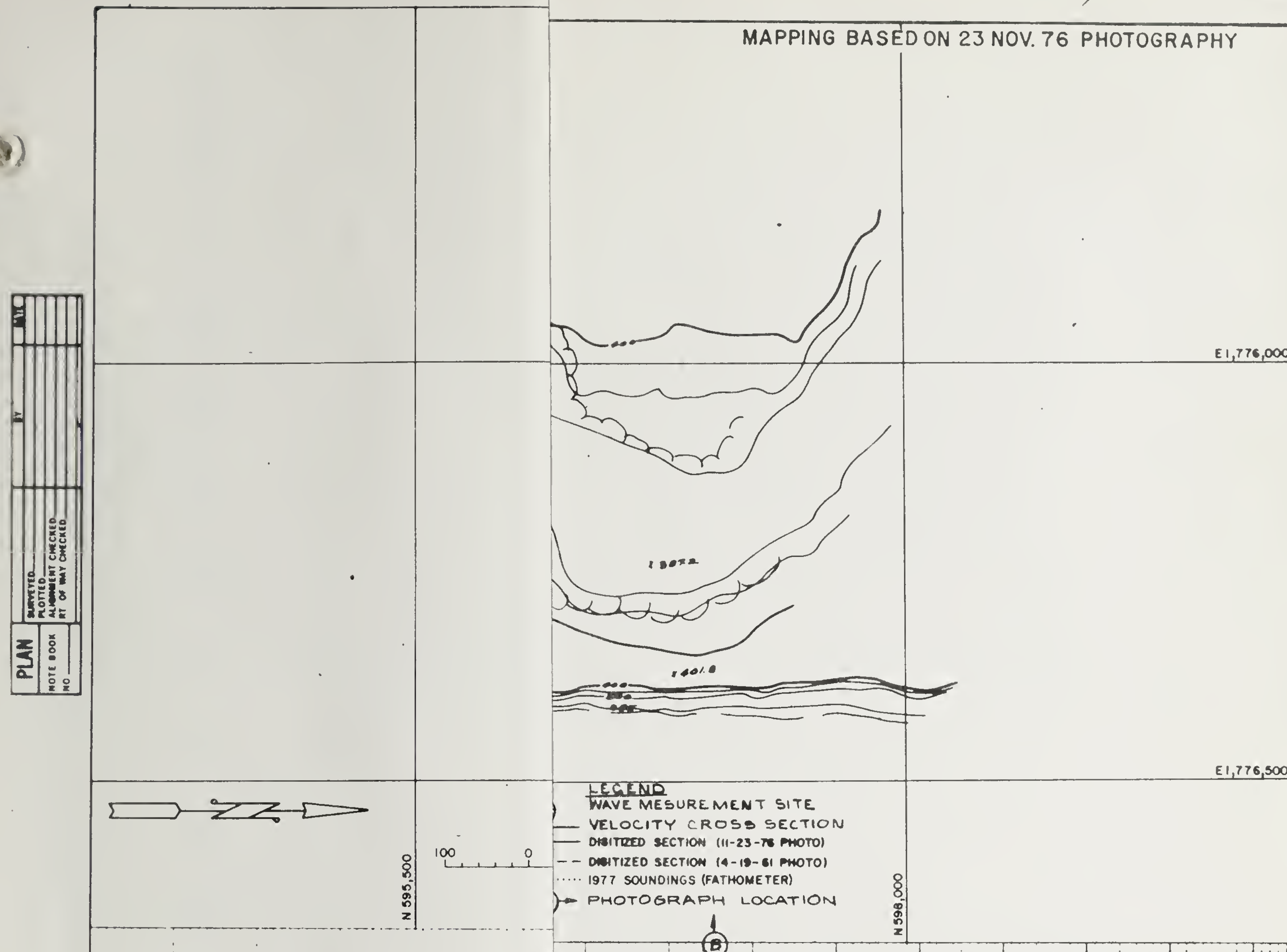
EARL LOESCH, ET UX

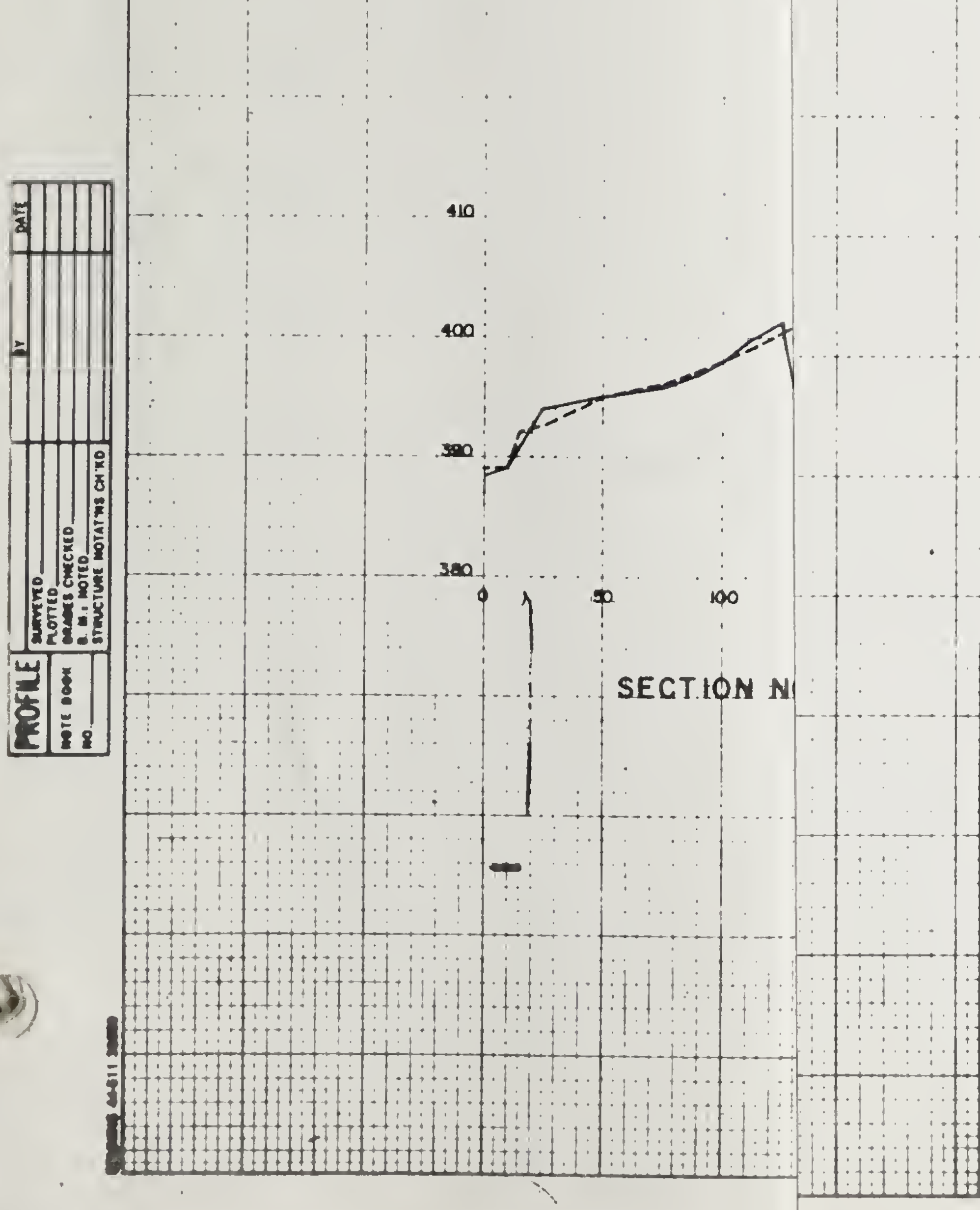
TRACTS 1300E-1, 1300E-2 & 1318E

SOIL & VEGETATION PROFILE

MILE 708.2

ORDXE JULY 77





U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

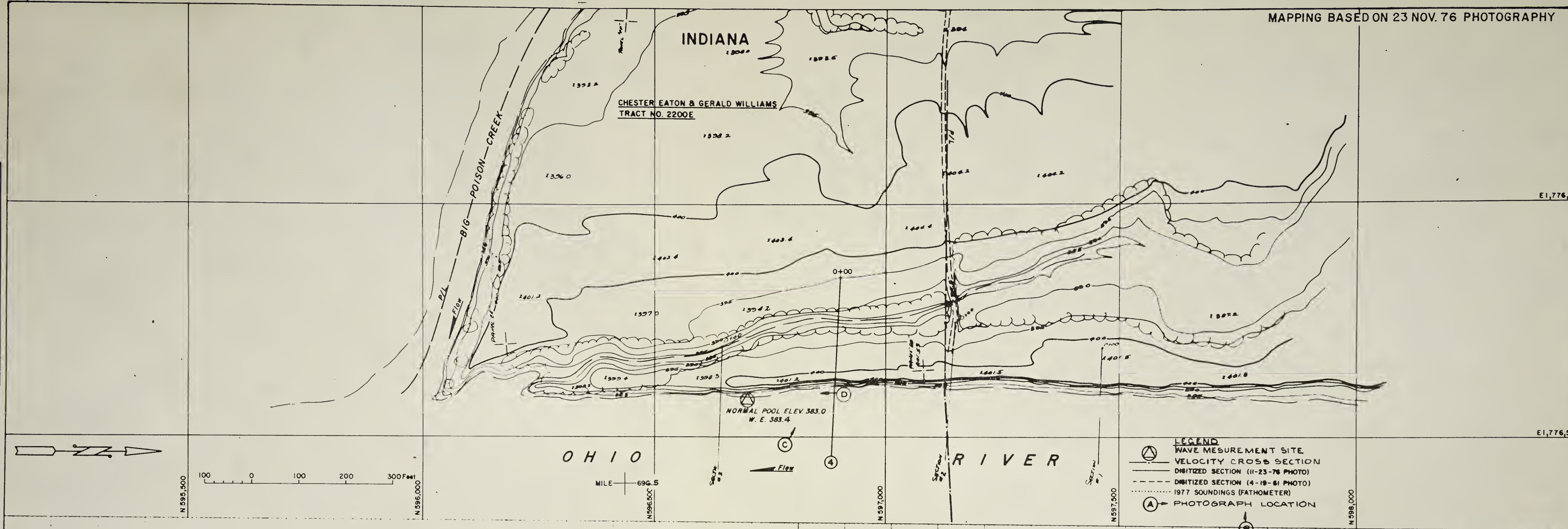
CANNELTON POOL

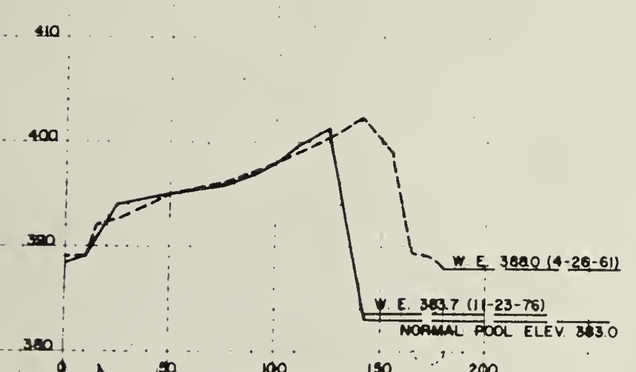
CHESTER EATON & GERALD WILLIAMS, TRACT 2200E

PLAN AND SECTION

MILE 698.4

ORDXE JULY 77





SECTION NO. 4

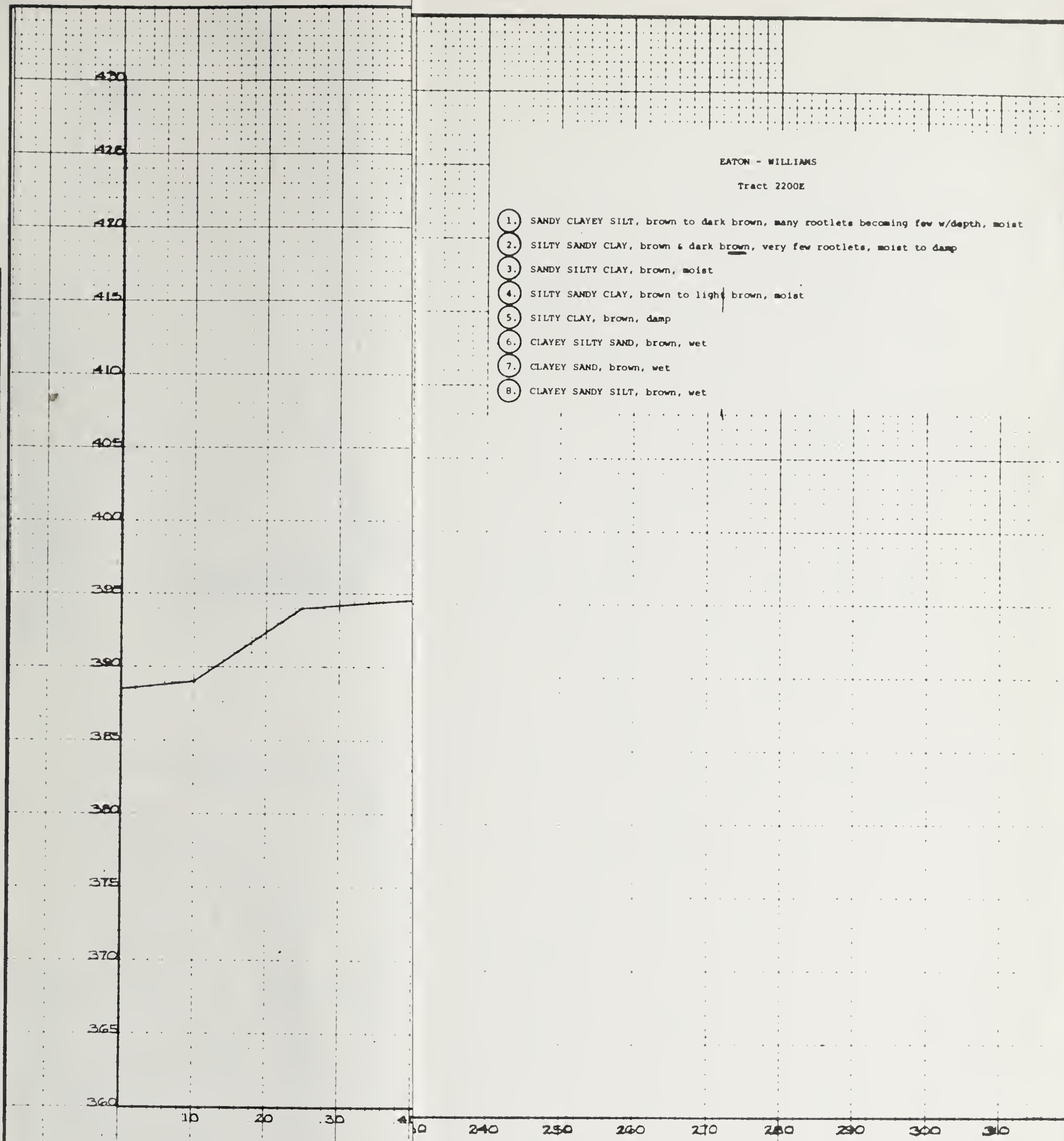
U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY

CANNELTON POOL

CHESTER EATON & GERALD WILLIAMS, TRACT 2200E
PLAN AND SECTION
MILE 696.4

ORDXE JULY 77

PLATE 42



EATON - WILLIAMS

Tract 2200E

1. SANDY CLAYEY SILT, brown to dark brown, many rootlets becoming few w/depth, moist
2. SILTY SANDY CLAY, brown & dark brown, very few rootlets, moist to damp
3. SANDY SILTY CLAY, brown, moist
4. SILTY SANDY CLAY, brown to light brown, moist
5. SILTY CLAY, brown, damp
6. CLAYEY SILTY SAND, brown, wet
7. CLAYEY SAND, brown, wet
8. CLAYEY SANDY SILT, brown, wet

U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

CANNELTON POOL

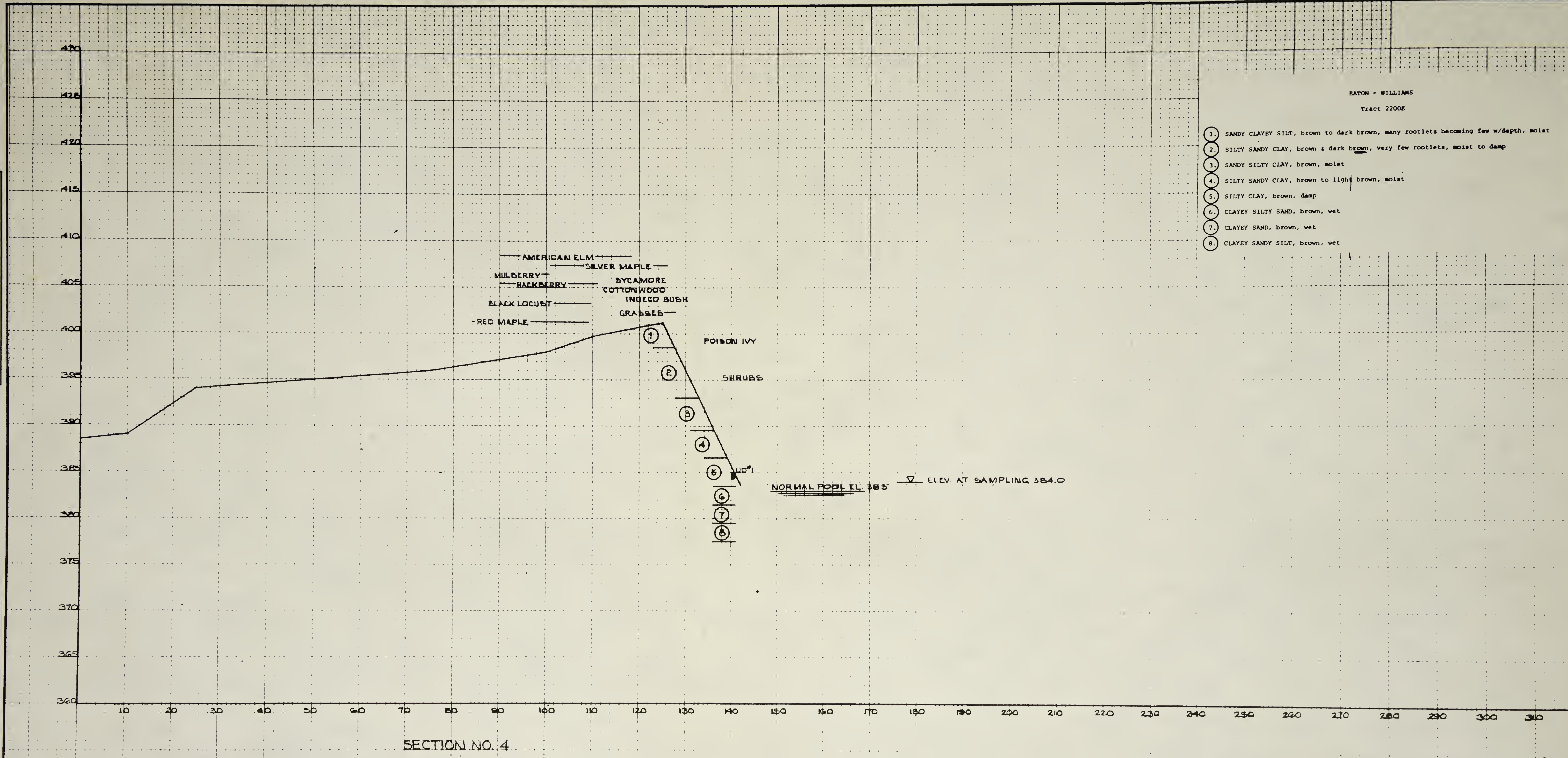
CHESTER EATON & GERALD WILLIAMS, TRACT 2200E

SOIL & VEGETATION PROFILE

MILE 695.4

ORDXE JULY 77

PLATE 42 SHEET 2 OF 2



U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

CANNELTON POOL

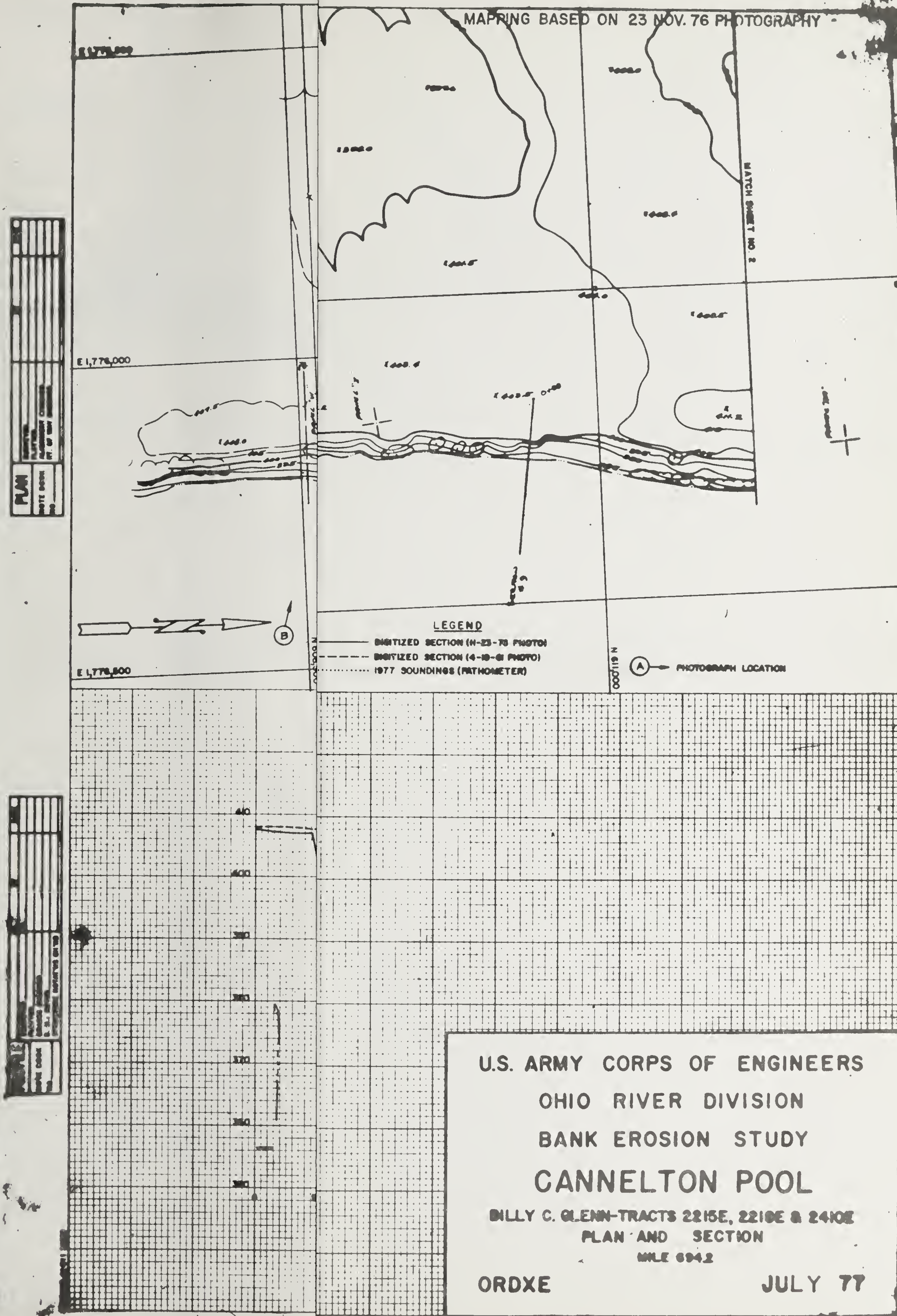
CHESTER EATON & GERALD WILLIAMS, TRACT 2200E

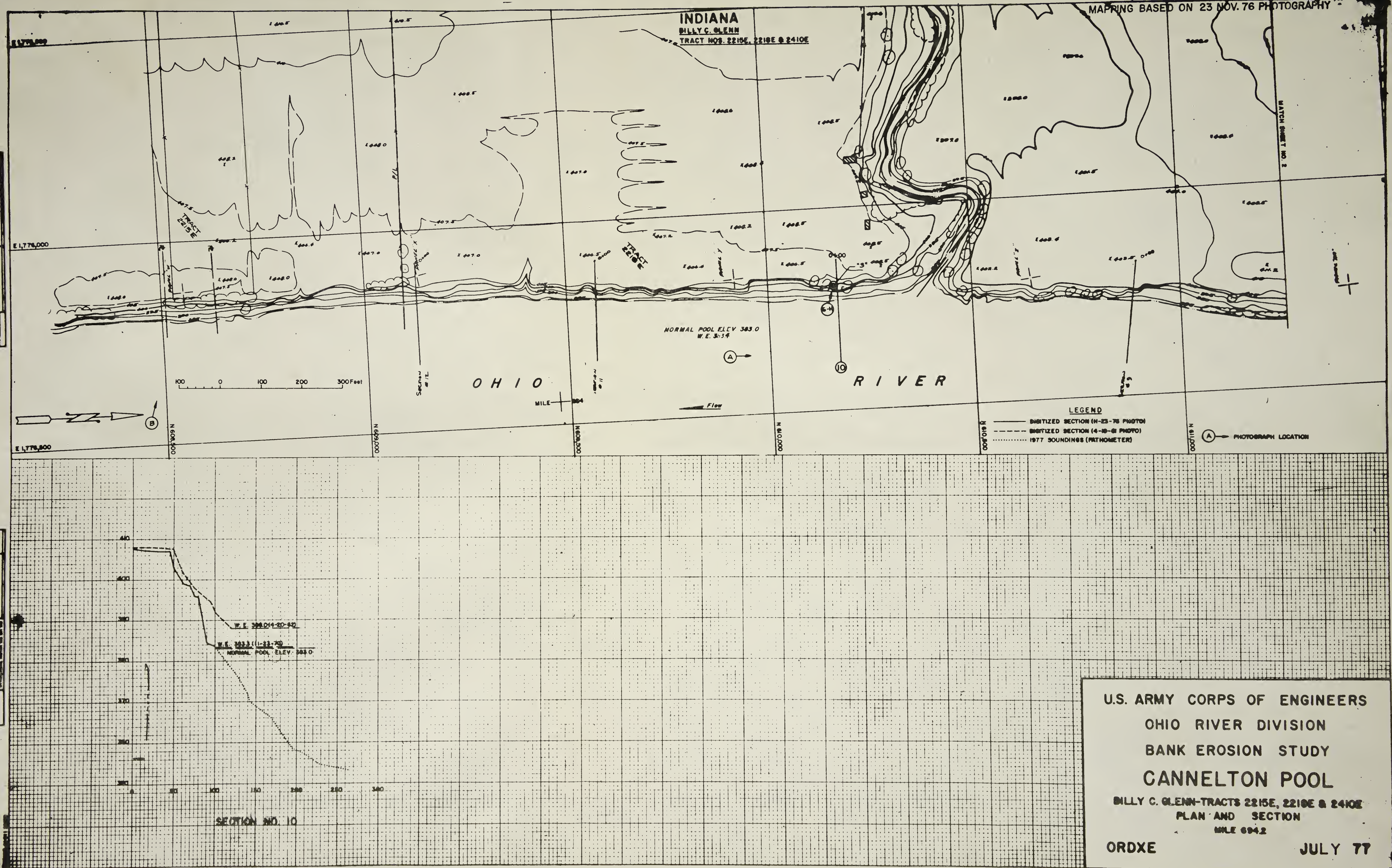
SOIL & VEGETATION PROFILE

MILE 695.4

ORDXE

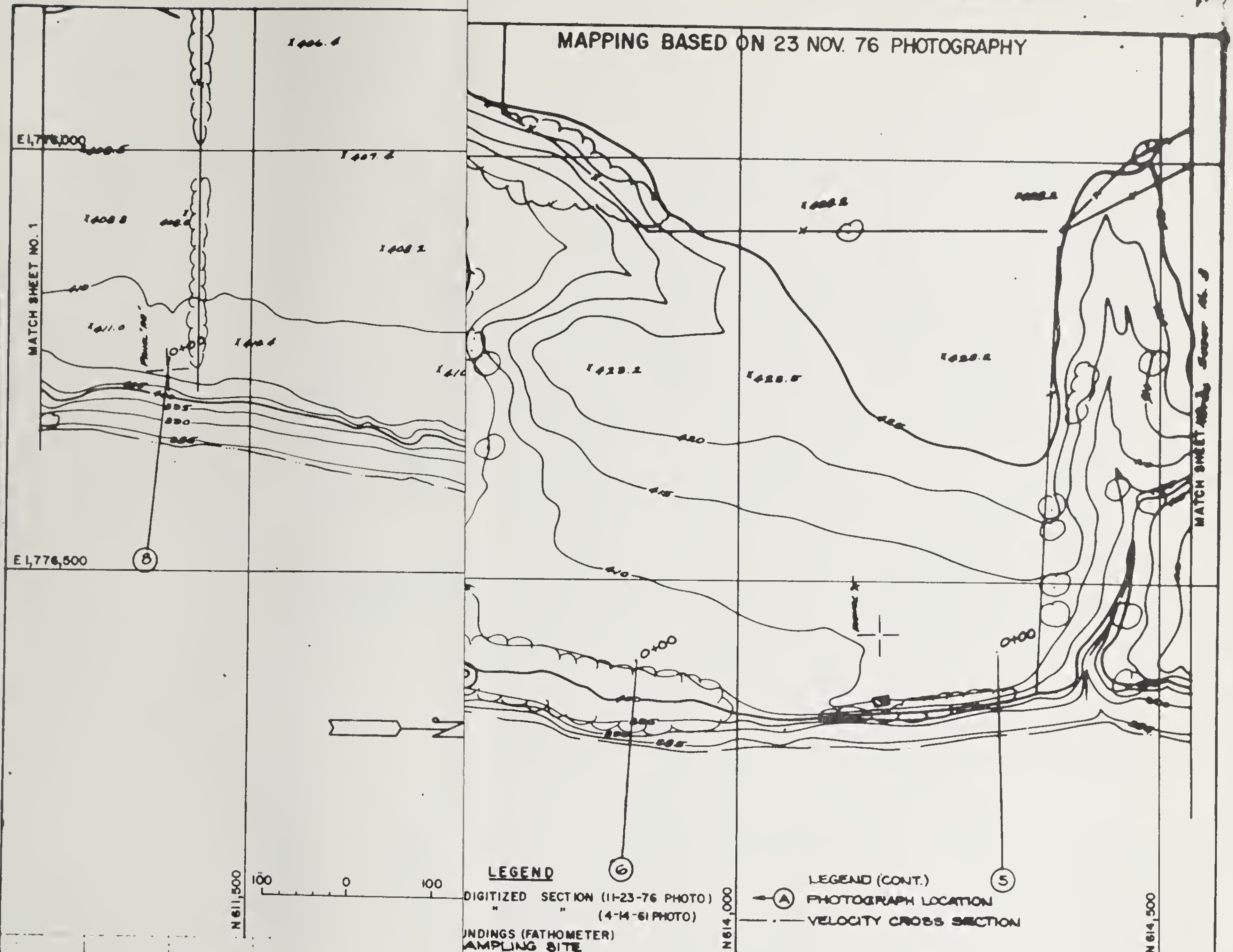
JULY 77

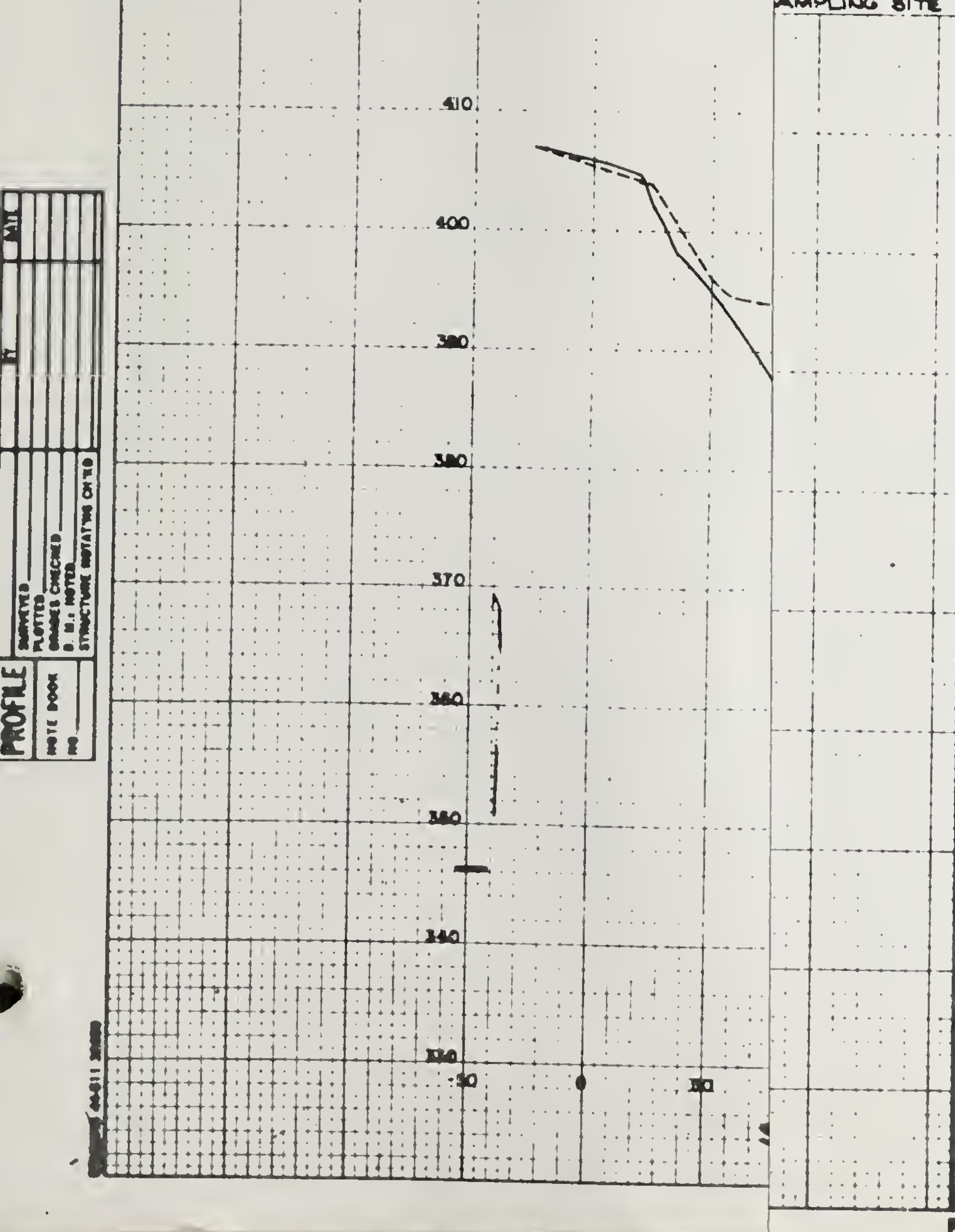

MAPPING BASED ON 23 NOV. 76 PHOTOGRAPHY
MATCH SHEET NO. 2
E 1,776,000
E 1,776,500
LEGEND
DIGITIZED SECTION (11-23-76 PHOTO)
DIGITIZED SECTION (4-19-61 PHOTO)
1977 SOUNDINGS (FATHOMETER)
PHOTOGRAPH LOCATION
PLAN
410
400
370
U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY
CANNELTON POOL
BILLY C. GLENN-TRACTS 2215E, 2216E & 2410E
PLAN AND SECTION
MILE 694.2
ORDXE
JULY 77



U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY
CANNELTON POOL
BILLY C. GLENN-TRACTS 2215E, 2216E & 2410E
PLAN AND SECTION
MILE 694.2
ORDXE
JULY 77

PLATE 43 REV. 7/15/77 SHEET 1 OF 5





U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

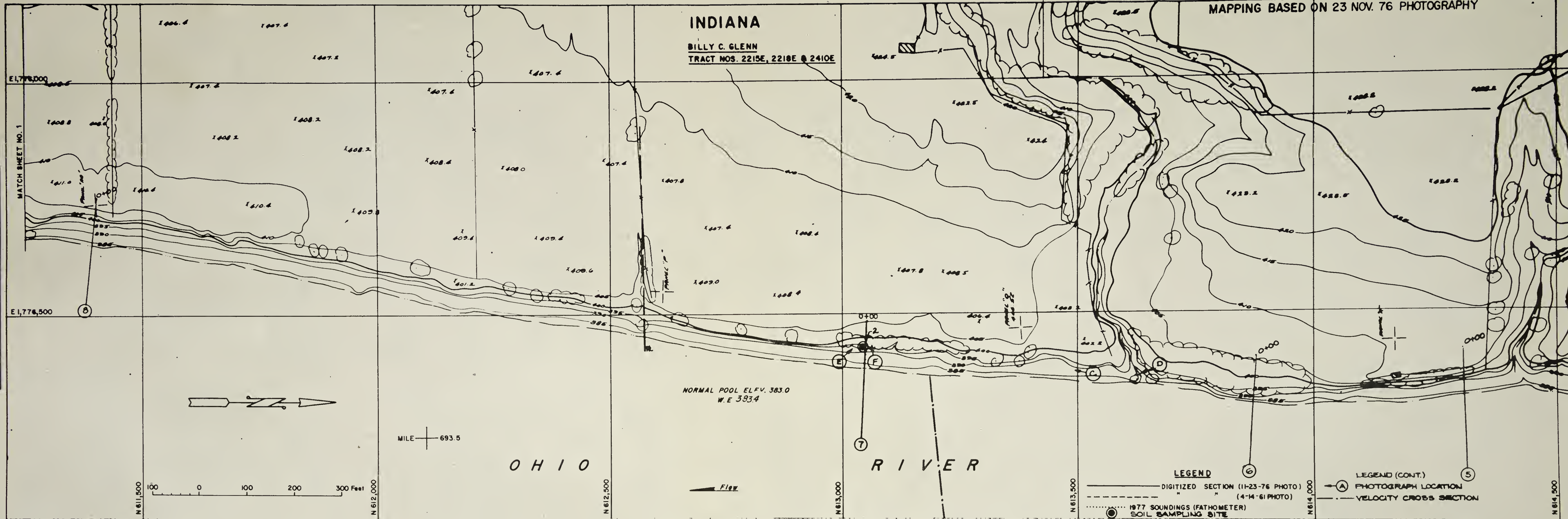
CANNELTON POOL

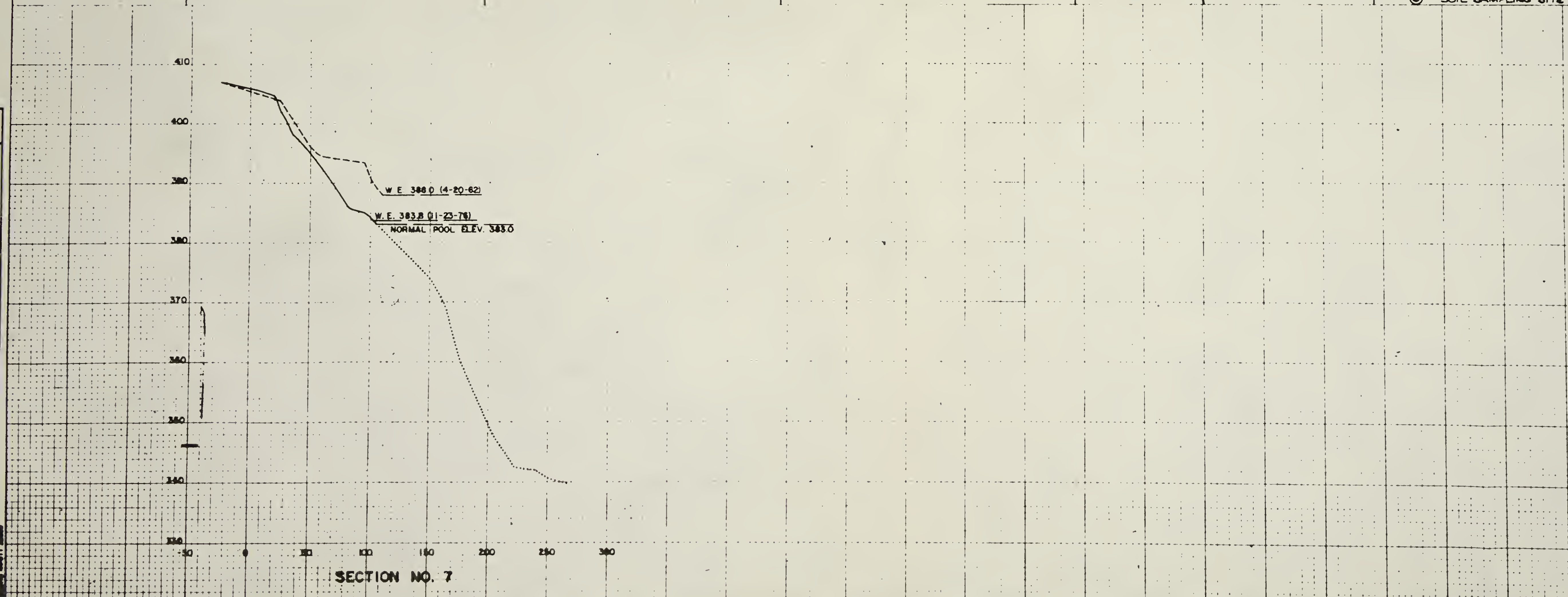
BILLY C. GLENN-TRACTS 2215E, 2218E & 2410E

PLAN AND SECTIONS

MILE 694.2

ORDXE JULY 77





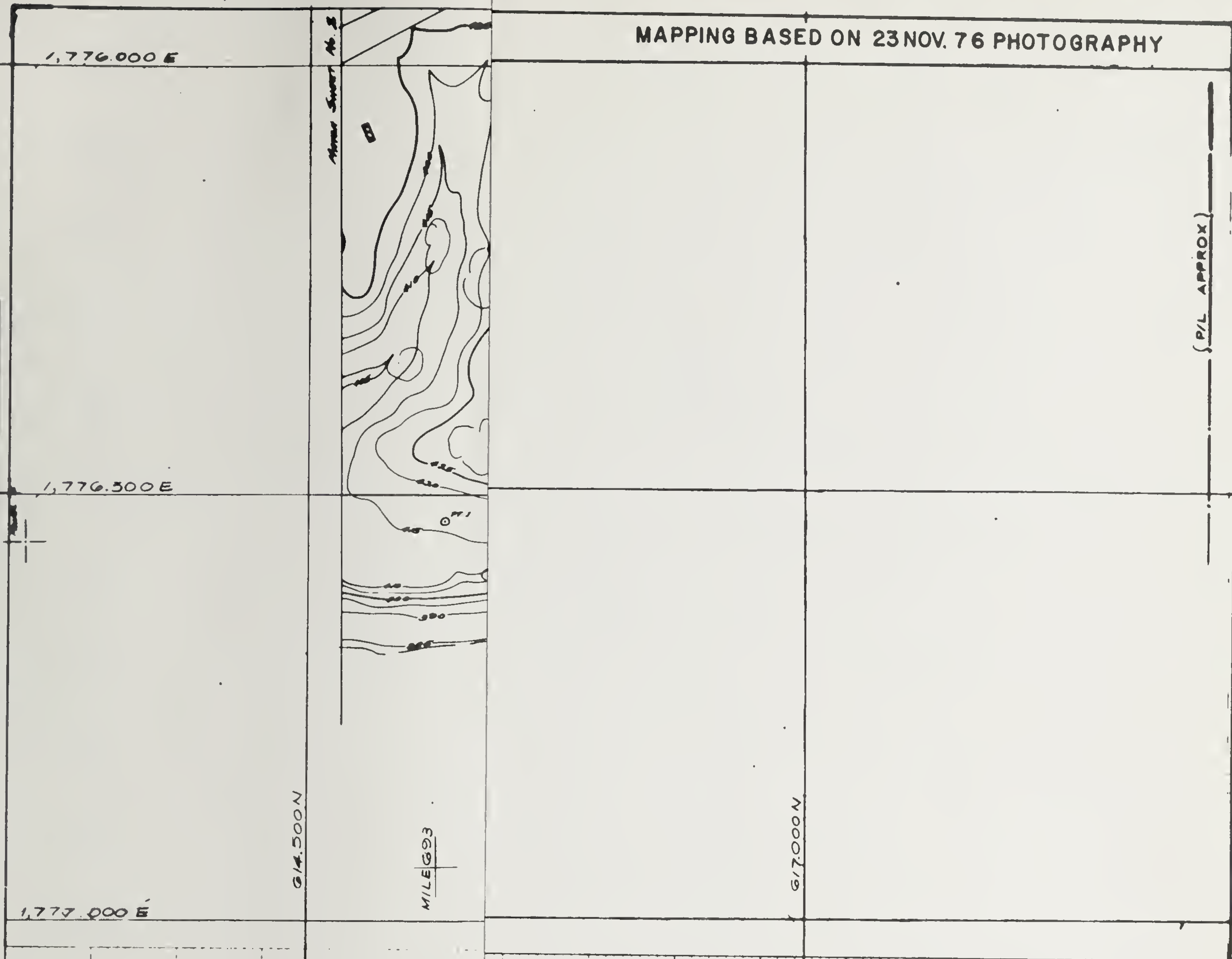
U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY

CANNELTON POOL

BILLY C. GLENN-TRACTS 2215E, 2218E & 2410E
PLAN AND SECTIONS
MILE 694.2

ORDXE JULY 77

PLATE 43



U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

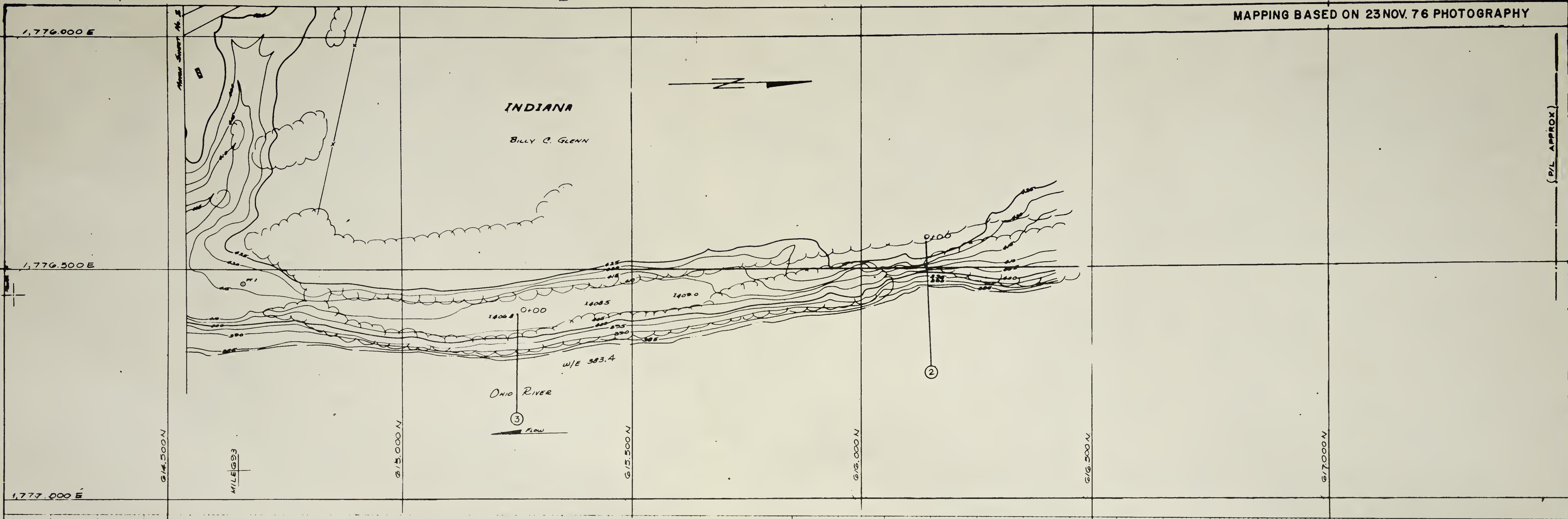
CANNELTON POOL

BILLY C. GLENN-TRACTS 2215E, 2218E & 2410E

PLAN

MILE 694.2

ORDXE JULY 77



U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

CANNELTON POOL

BILLY C. GLENN-TRACTS 2215E, 2218E & 2410E

PLAN

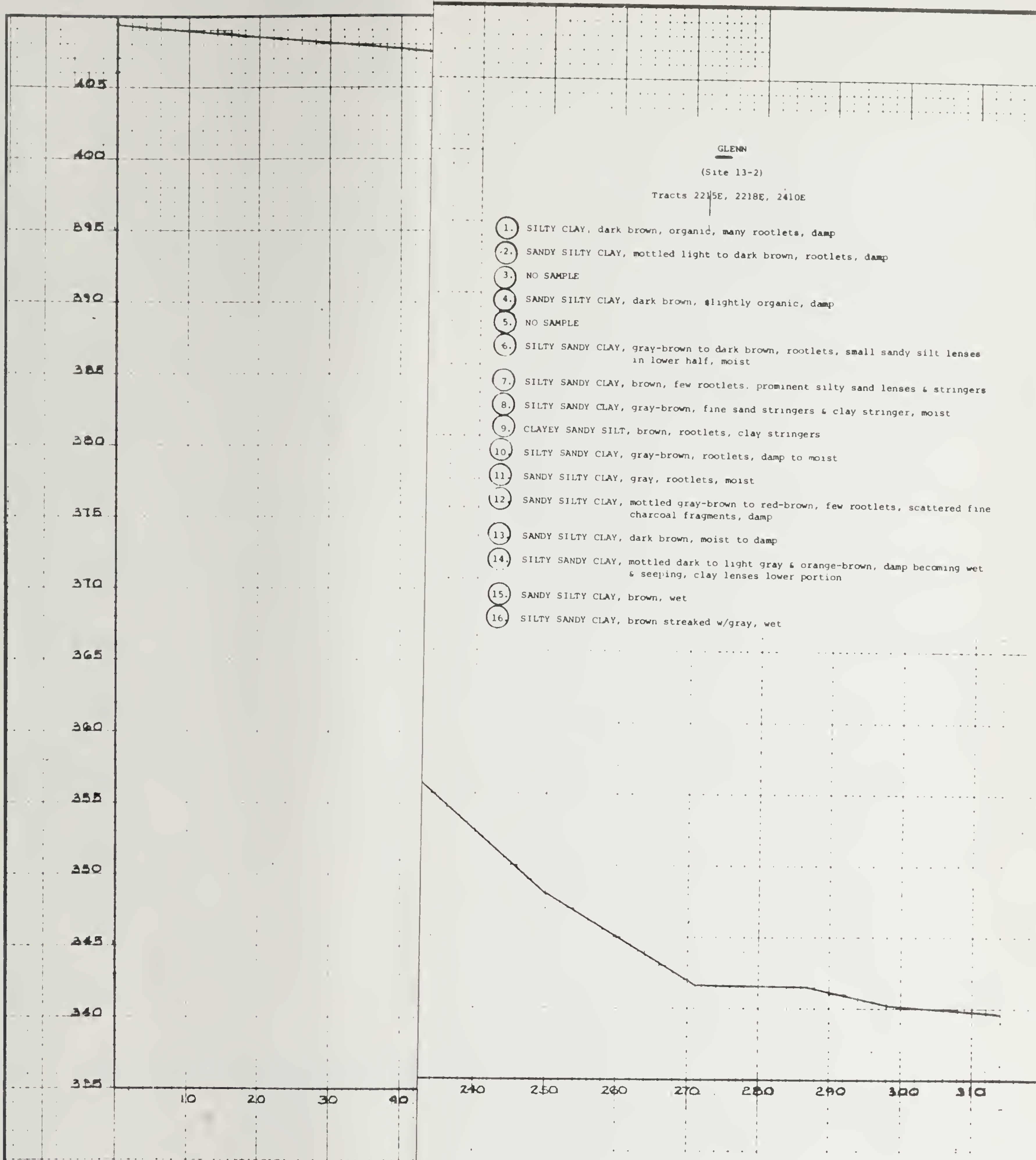
MILE 694.2

ORDXE

JULY 77

PLATE 43

SHEET 3 OF 8



GLENN

(Site 13-2)

Tracts 2215E, 2218E, 2410E

1. SILTY CLAY, dark brown, organic, many rootlets, damp
2. SANDY SILTY CLAY, mottled light to dark brown, rootlets, damp
3. NO SAMPLE
4. SANDY SILTY CLAY, dark brown, slightly organic, damp
5. NO SAMPLE
6. SILTY SANDY CLAY, gray-brown to dark brown, rootlets, small sandy silt lenses in lower half, moist
7. SILTY SANDY CLAY, brown, few rootlets. prominent silty sand lenses & stringers
8. SILTY SANDY CLAY, gray-brown, fine sand stringers & clay stringer, moist
9. CLAYEY SANDY SILT, brown, rootlets, clay stringers
10. SILTY SANDY CLAY, gray-brown, rootlets, damp to moist
11. SANDY SILTY CLAY, gray, rootlets, moist
12. SANDY SILTY CLAY, mottled gray-brown to red-brown, few rootlets, scattered fine charcoal fragments, damp
13. SANDY SILTY CLAY, dark brown, moist to damp
14. SILTY SANDY CLAY, mottled dark to light gray & orange-brown, damp becoming wet & seeping, clay lenses lower portion
15. SANDY SILTY CLAY, brown, wet
16. SILTY SANDY CLAY, brown streaked w/gray, wet

U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

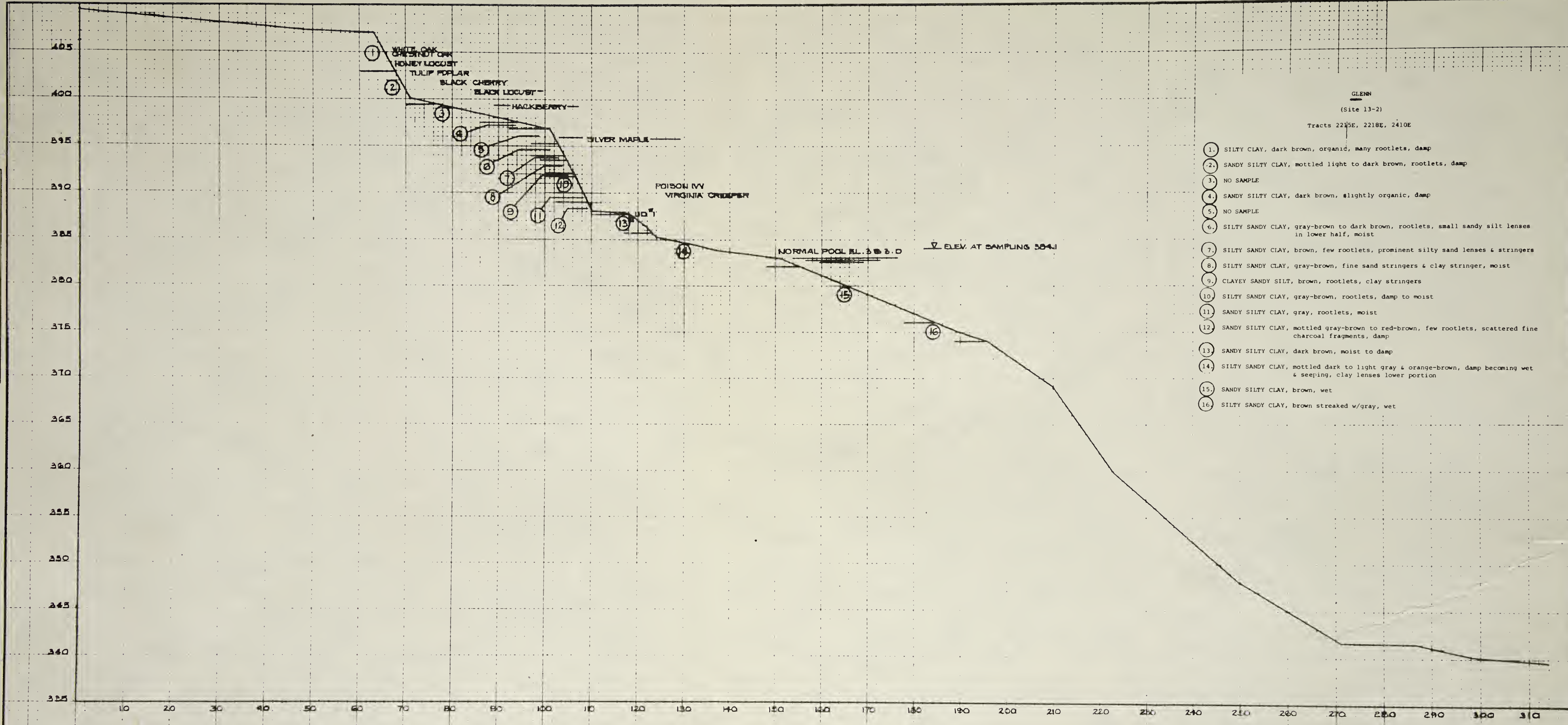
CANNELTON POOL

BILLY C. GLENN-TRACTS 2215E, 2218E & 2410E

SOIL & VEGETATION PROFILE

MILE 694.2

ORDXE JULY 77



SECTION NO. 7

GLENN

(Site 13-2)

Tracts 2215E, 2218E, 2410E

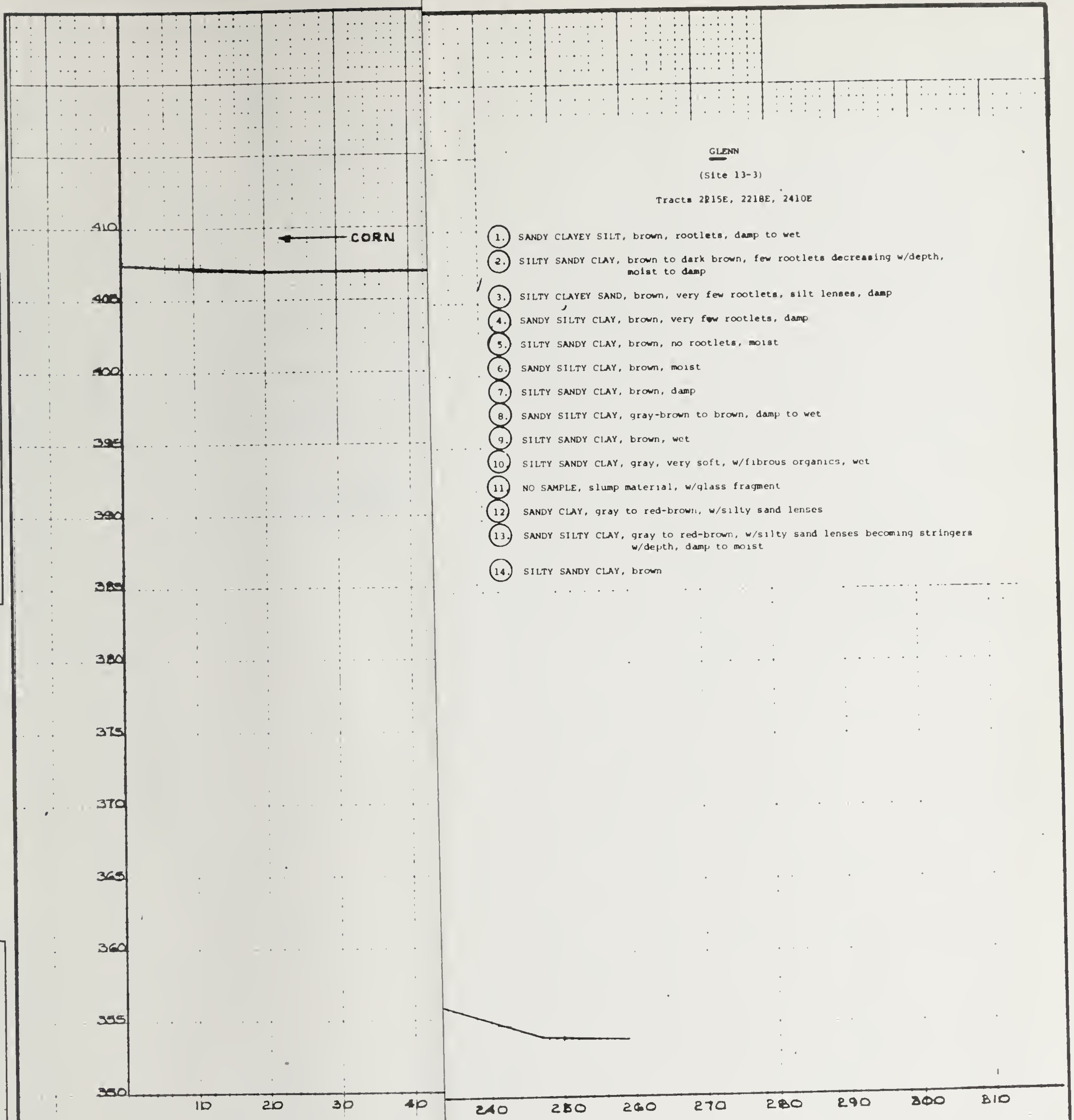
1. SILTY CLAY, dark brown, organic, many rootlets, damp
2. SANDY SILTY CLAY, mottled light to dark brown, rootlets, damp
3. NO SAMPLE
4. SANDY SILTY CLAY, dark brown, slightly organic, damp
5. NO SAMPLE
6. SILTY SANDY CLAY, gray-brown to dark brown, rootlets, small sandy silt lenses in lower half, moist
7. SILTY SANDY CLAY, brown, few rootlets, prominent silty sand lenses & stringers
8. SILTY SANDY CLAY, gray-brown, fine sand stringers & clay stringer, moist
9. CLAYEY SANDY SILT, brown, rootlets, clay stringers
10. SILTY SANDY CLAY, gray-brown, rootlets, damp to moist
11. SANDY SILTY CLAY, gray, rootlets, moist
12. SANDY SILTY CLAY, mottled gray-brown to red-brown, few rootlets, scattered fine charcoal fragments, damp
13. SANDY SILTY CLAY, dark brown, moist to damp
14. SILTY SANDY CLAY, mottled dark to light gray & orange-brown, damp becoming wet & seeping, clay lenses lower portion
15. SANDY SILTY CLAY, brown, wet
16. SILTY SANDY CLAY, brown streaked w/gray, wet

U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY

CANNELTON POOL

BILLY C. GLENN-TRACTS 2215E, 2218E & 2410E
SOIL & VEGETATION PROFILE
MILE 694.2

ORDXE JULY 77



GLENN

(Site 13-3)

Tracts 2215E, 2218E, 2410E

1. SANDY CLAYEY SILT, brown, rootlets, damp to wet
2. SILTY SANDY CLAY, brown to dark brown, few rootlets decreasing w/depth, moist to damp
3. SILTY CLAYEY SAND, brown, very few rootlets, silt lenses, damp
4. SANDY SILTY CLAY, brown, very few rootlets, damp
5. SILTY SANDY CLAY, brown, no rootlets, moist
6. SANDY SILTY CLAY, brown, moist
7. SILTY SANDY CLAY, brown, damp
8. SANDY SILTY CLAY, gray-brown to brown, damp to wet
9. SILTY SANDY CLAY, brown, wet
10. SILTY SANDY CLAY, gray, very soft, w/fibrous organics, wet
11. NO SAMPLE, slump material, w/glass fragment
12. SANDY CLAY, gray to red-brown, w/silty sand lenses
13. SANDY SILTY CLAY, gray to red-brown, w/silty sand lenses becoming stringers w/depth, damp to moist
14. SILTY SANDY CLAY, brown

U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

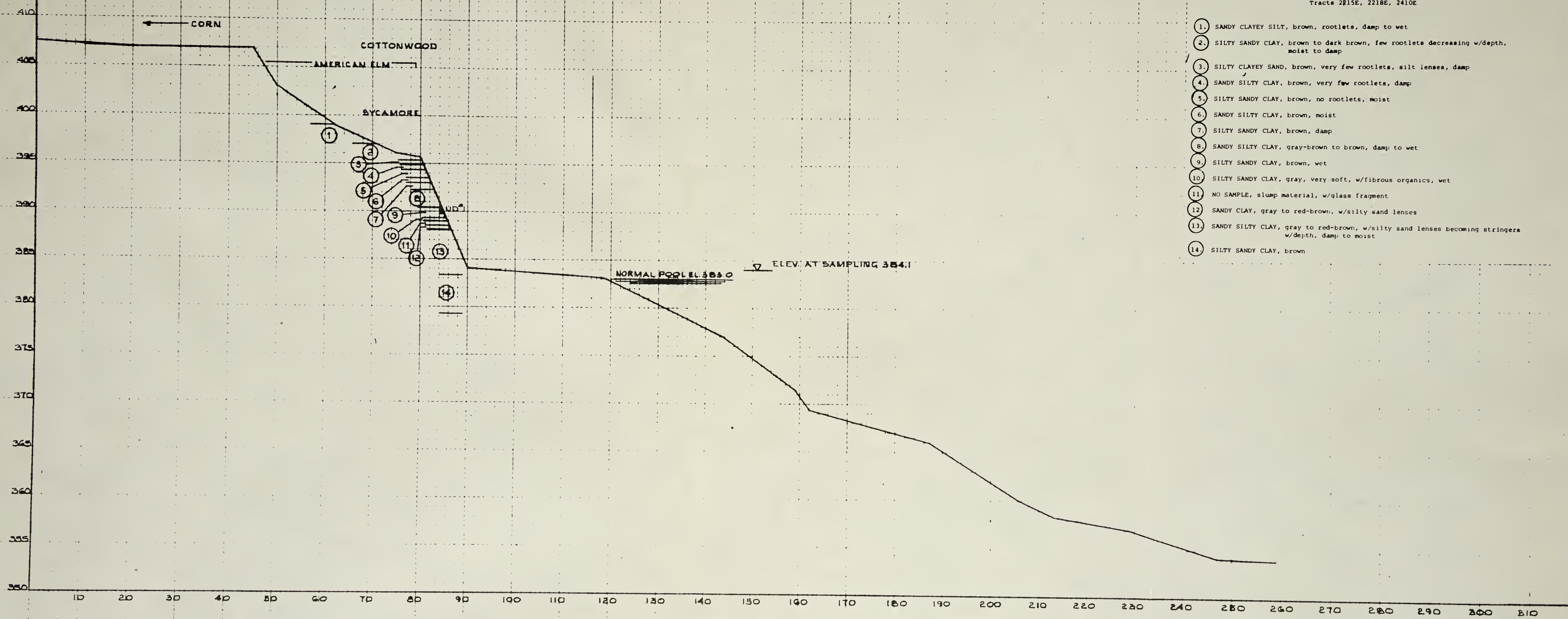
CANNELTON POOL

BILLY C. GLENN-TRACTS 2215E, 2218E & 2410E

SOIL & VEGETATION PROFILE

MILE 694.2

ORDXE JULY 77



SECTION NO.10

GLENN

(Site 13-3)

Tracts 2215E, 2218E, 2410E

1. SANDY CLAYEY SILT, brown, rootlets, damp to wet
2. SILTY SANDY CLAY, brown to dark brown, few rootlets decreasing w/depth, moist to damp
3. SILTY CLAYEY SAND, brown, very few rootlets, silt lenses, damp
4. SANDY SILTY CLAY, brown, very few rootlets, damp
5. SILTY SANDY CLAY, brown, no rootlets, moist
6. SANDY SILTY CLAY, brown, moist
7. SILTY SANDY CLAY, brown, damp
8. SANDY SILTY CLAY, gray-brown to brown, damp to wet
9. SILTY SANDY CLAY, brown, wet
10. SILTY SANDY CLAY, gray, very soft, w/fibrous organics, wet
11. NO SAMPLE, slump material, w/glass fragment
12. SANDY CLAY, gray to red-brown, w/silty sand lenses
13. SANDY SILTY CLAY, gray to red-brown, w/silty sand lenses becoming stringers w/depth, damp to moist
14. SILTY SANDY CLAY, brown

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OHIO RIVER DIVISION
BANK EROSION STUDY

CANNELTON POOL

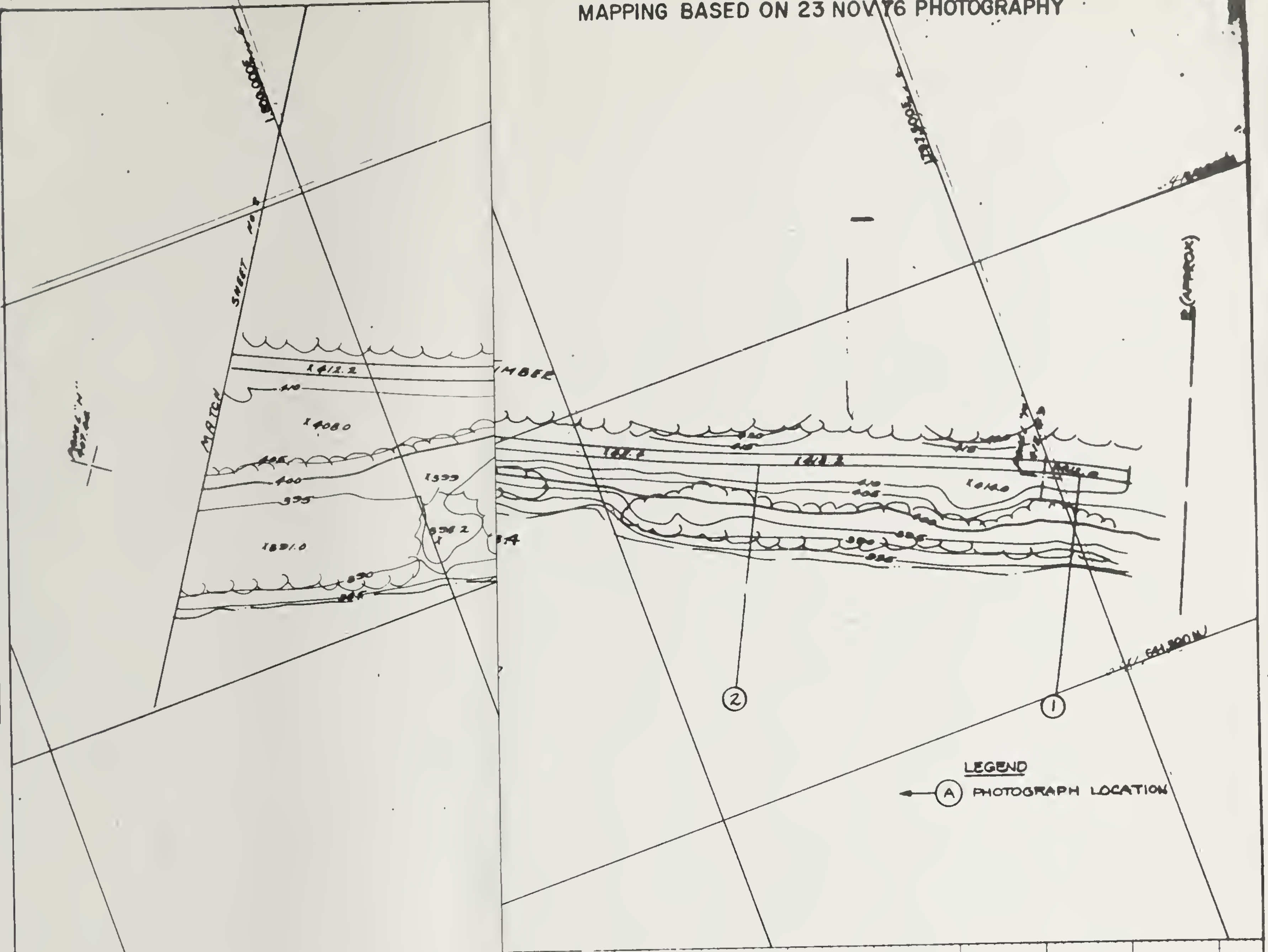
BILLY C. GLENN-TRACTS 2215E, 2218E & 2410E
SOIL & VEGETATION PROFILE
MILE 694.2

ORDXE JULY 77

PLATE 43

SHEET 5 OF 5

MAPPING BASED ON 23 NOV 76 PHOTOGRAPHY



PLAN		BY	DATE
NOTE BOOK	SURVEYED		
NO	PLOTTED		
	ALIGNMENT CHECKED		
	RT OF WAY CHECKED		

PROFILE		BY	DATE
NOTE BOOK	SURVEYED		
NO	PLOTTED		
	GRADES CHECKED		
	B. M.s NOTED		
	STRUCTURE NOTAT'NS CH'KD		

U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

CANNELTON POOL

CLYDE BENNER, ET UX-TRACT 3015E

PLAN

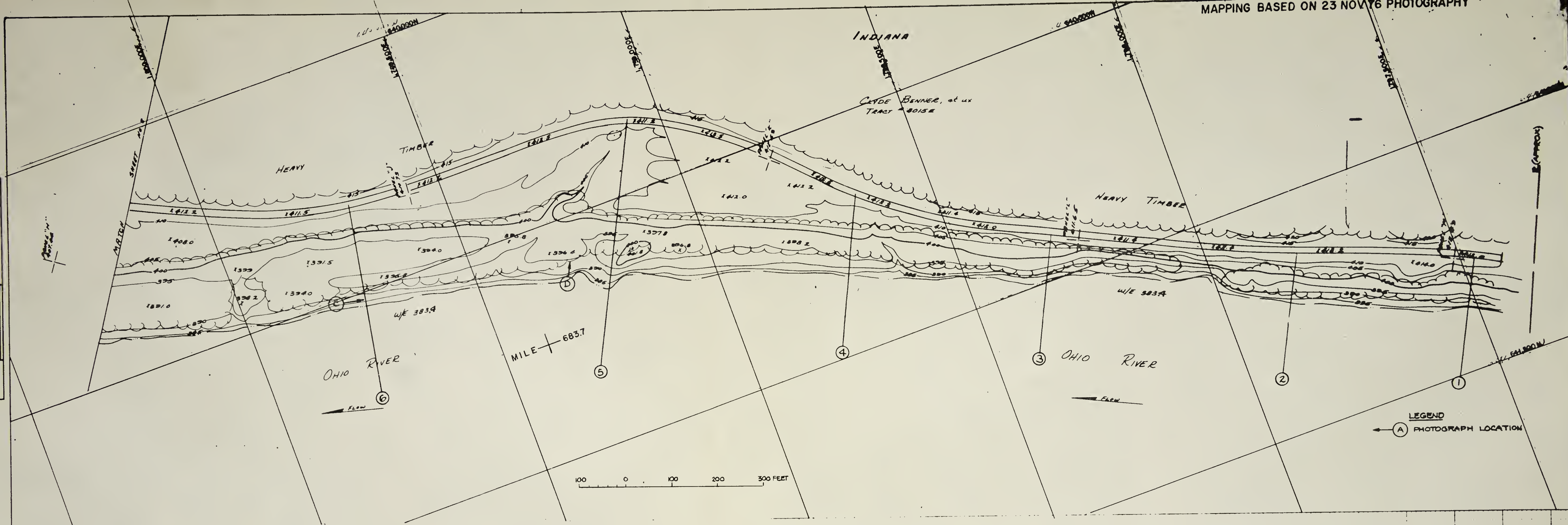
MILE 683.7

ORDXE JULY 77

PLATE 44

SHEET 1 OF 3

BRUNING 44.511 32850



PLAN

PROFILE

U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

CANNELTON POOL

CLYDE BENNER, ET UX-TRACT 3015E

PLAN

MILE 683.7

ORDXE JULY 77

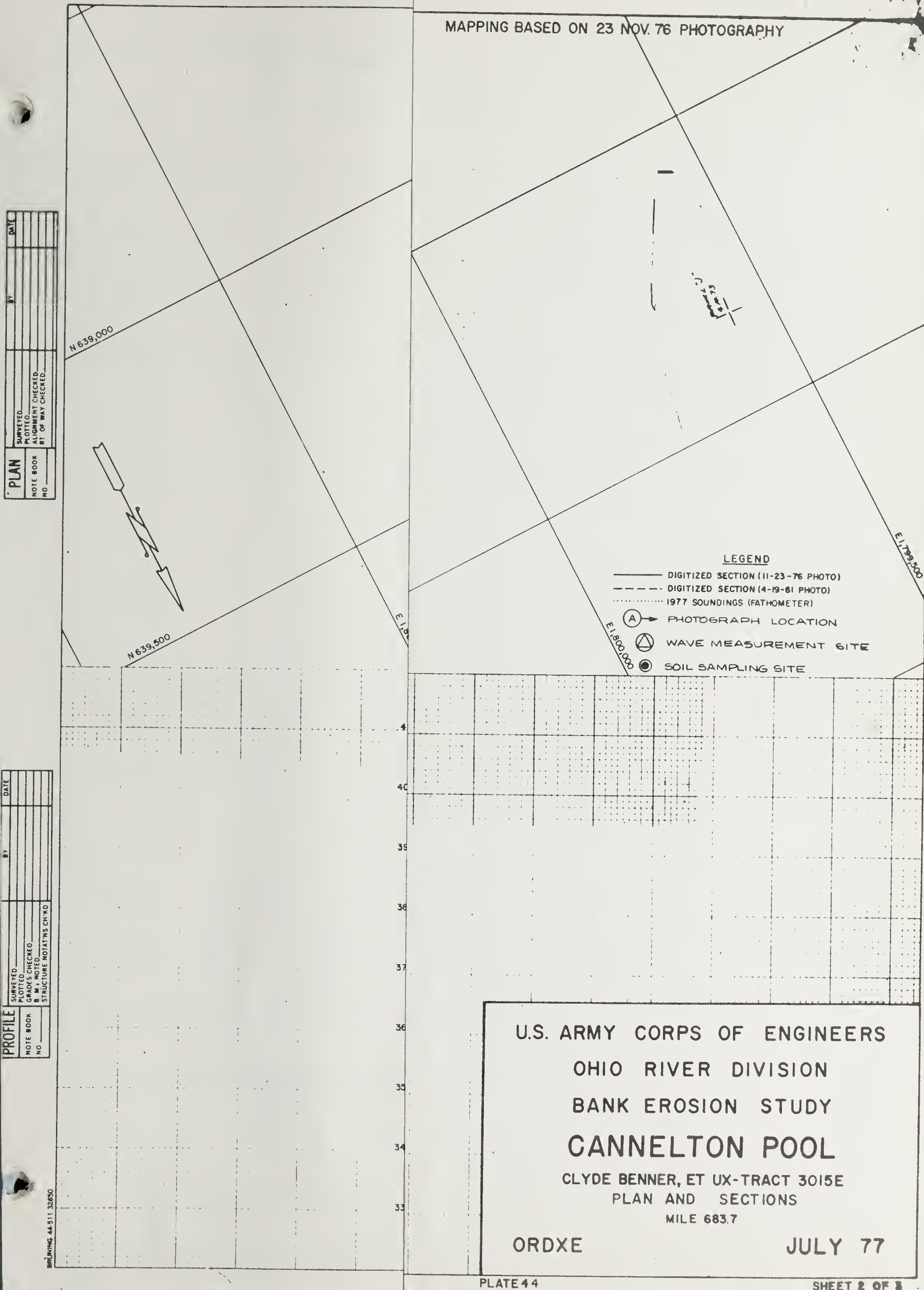
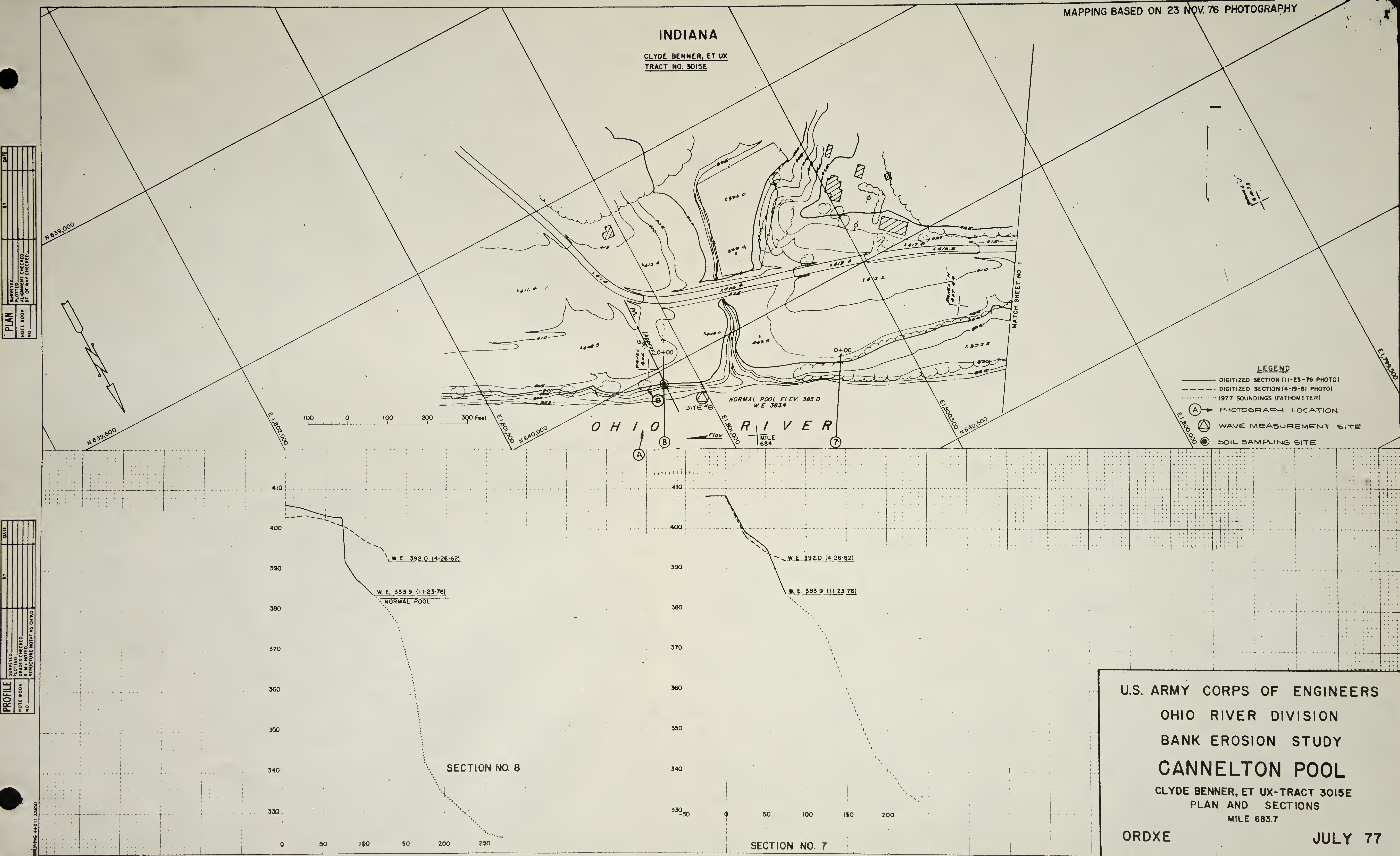


PLATE 44

SHEET 2 OF 3



U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

CANNELTON POOL

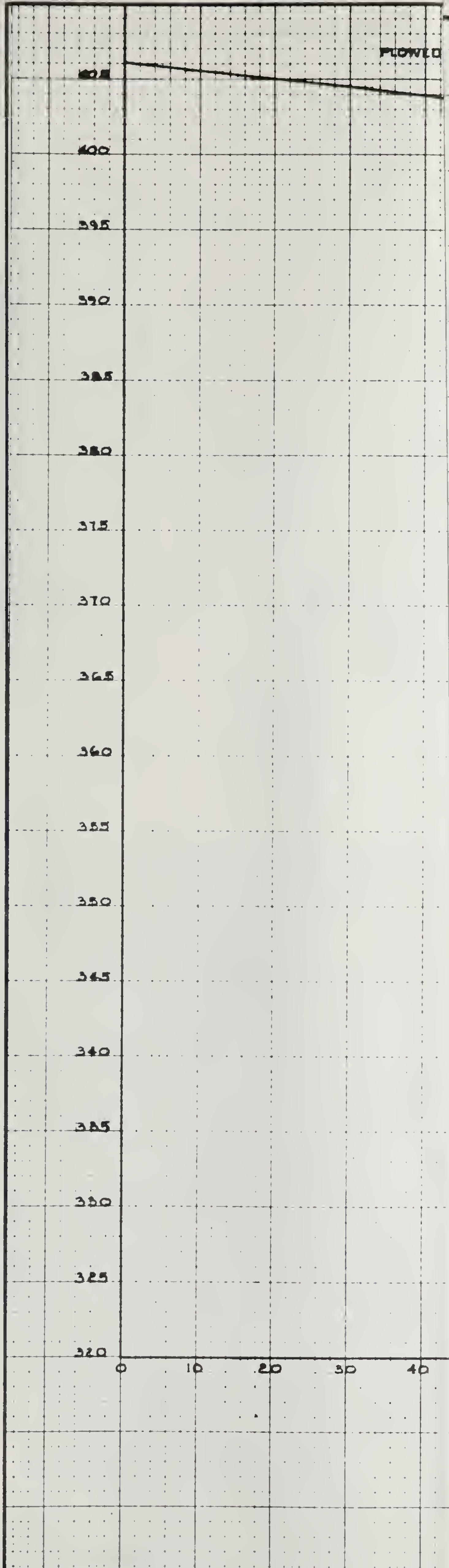
CLYDE BENNER, ET UX-TRACT 3015E

PLAN AND SECTIONS

MILE 683.7

ORDXE JULY 77

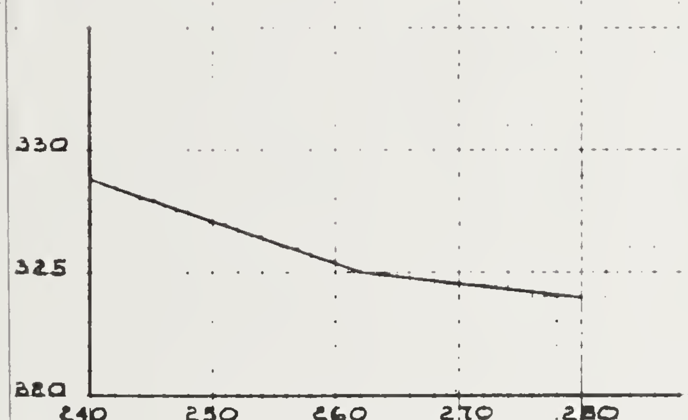
PLATE 44



BENNER

Tract 3015E

1. CLAYEY SANDY SILT, light brown, w/layered cross bedded sand seams & fragments of wood, glass & flint
2. CLAYEY SANDY SILT, brown, w/silty sand layers becoming lenses w/depth, worm casts & rootlets, damp
3. SANDY CLAYEY SILT, brown, w/fine sand layers & rootlets, grading coarser w/depth, damp
4. CLAYEY SILTY SAND, light brown, w/cleaner sand layers, damp
5. SANDY SILTY CLAY, brown, damp becoming wet w/depth



240

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OHIO RIVER DIVISION

BANK EROSION STUDY

CANNELTON POOL

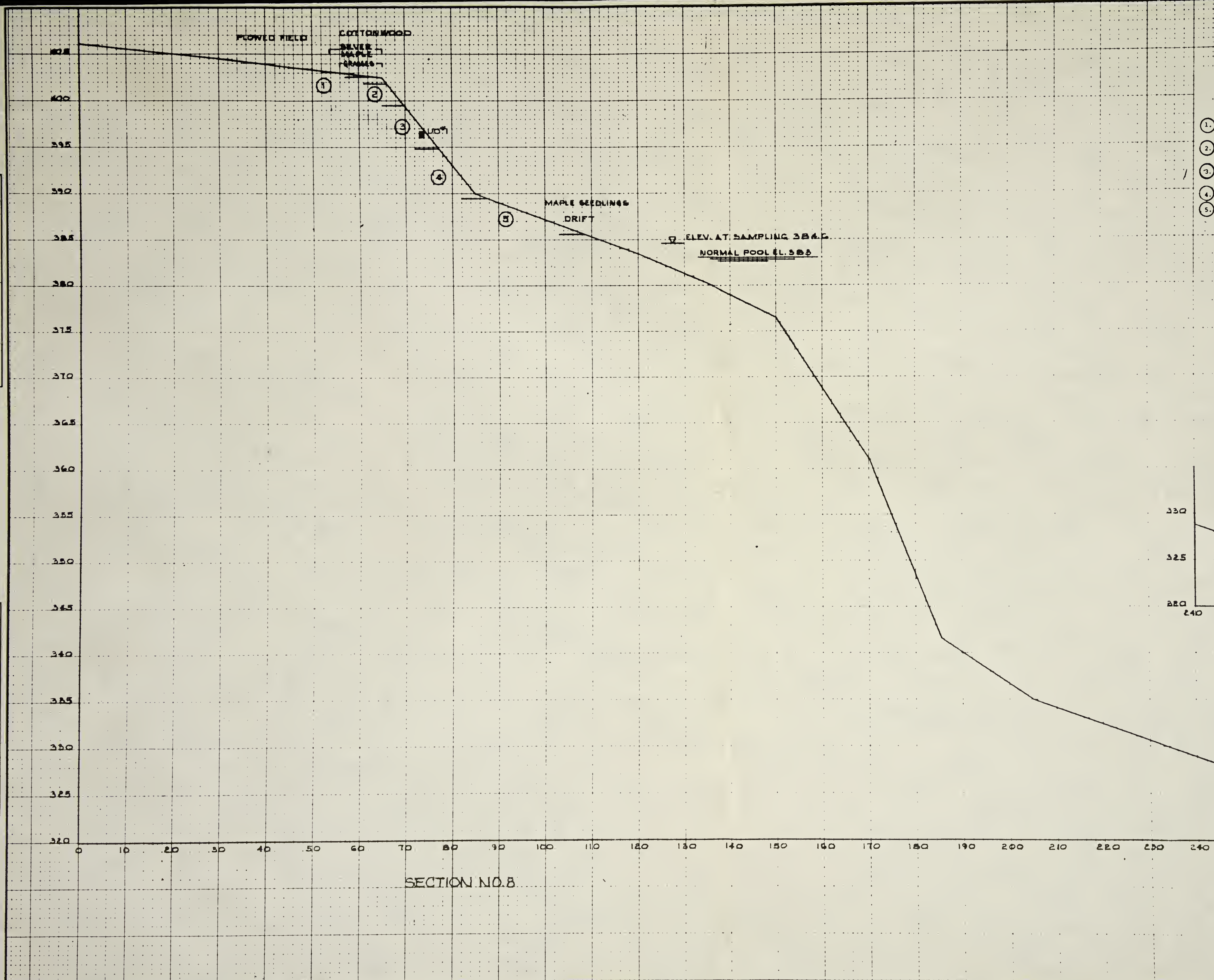
CLYDE BENNER, ET UX-TRACT 3015E

SOIL & VEGETATION PROFILE

MILE 683.7

ORDXE JULY 77

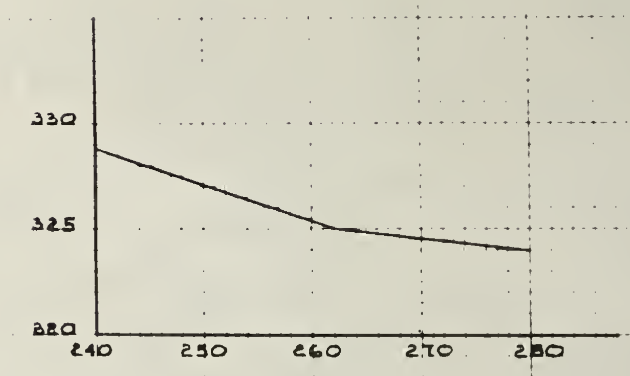
PLATE 44 PLATE SHEET 3 OF 3



BENNER

Tract 3015E

1. CLAYEY SANDY SILT, light brown, w/layered cross bedded sand seams & fragments of wood, glass & flint
2. CLAYEY SANDY SILT, brown, w/silty sand layers becoming lenses w/depth, worm casts & rootlets, damp
3. SANDY CLAYEY SILT, brown, w/fine sand layers & rootlets, grading coarser w/depth, damp
4. CLAYEY SILTY SAND, light brown, w/cleaner sand layers, damp
5. SANDY SILTY CLAY, brown, damp becoming wet w/depth

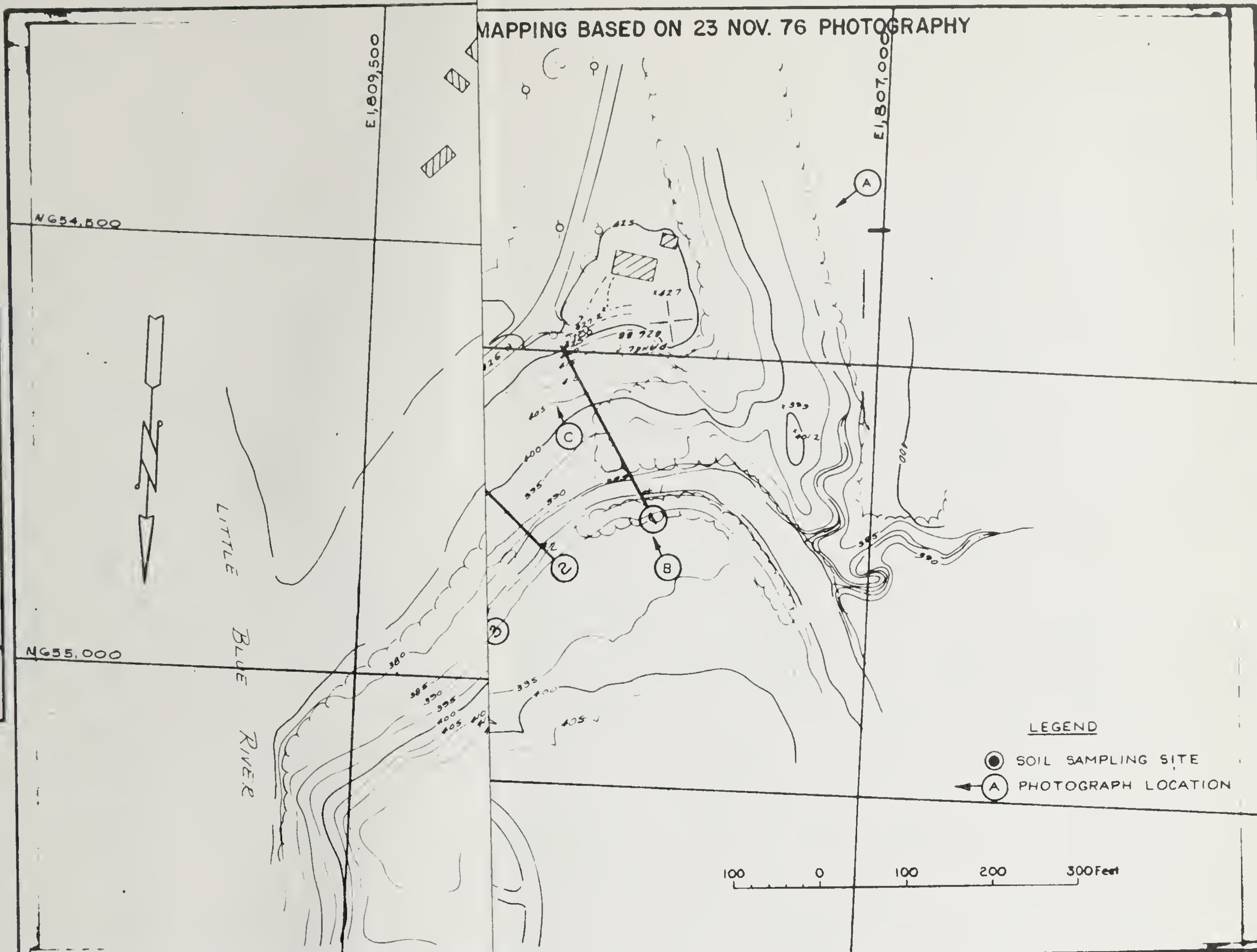


U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY

CANNELTON POOL

CLYDE BENNER, ET UX-TRACT 3015E
SOIL & VEGETATION PROFILE
MILE 683.7

ORDXE JULY 77



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OHIO RIVER DIVISION

BANK EROSION STUDY

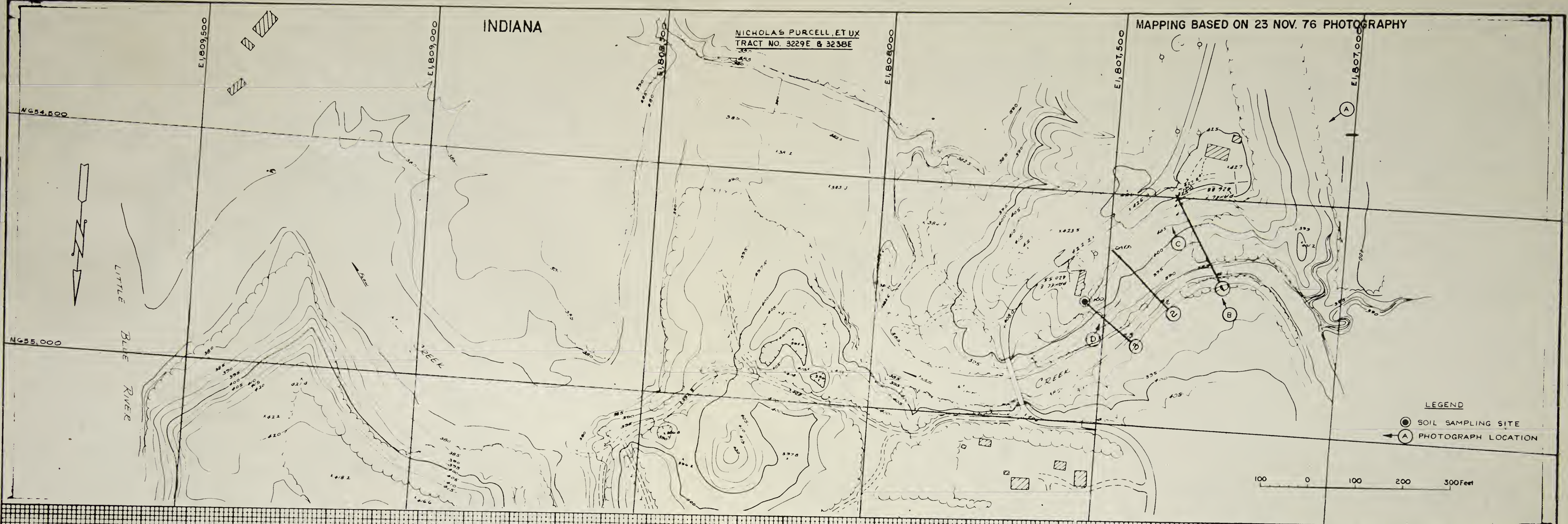
CANNELTON POOL

NICHOLAS PURCELL, ET UK-TRACTS 3229E & 3230E

PLAN

MILE 678.5

ORDXE JULY 77



NO SECTION

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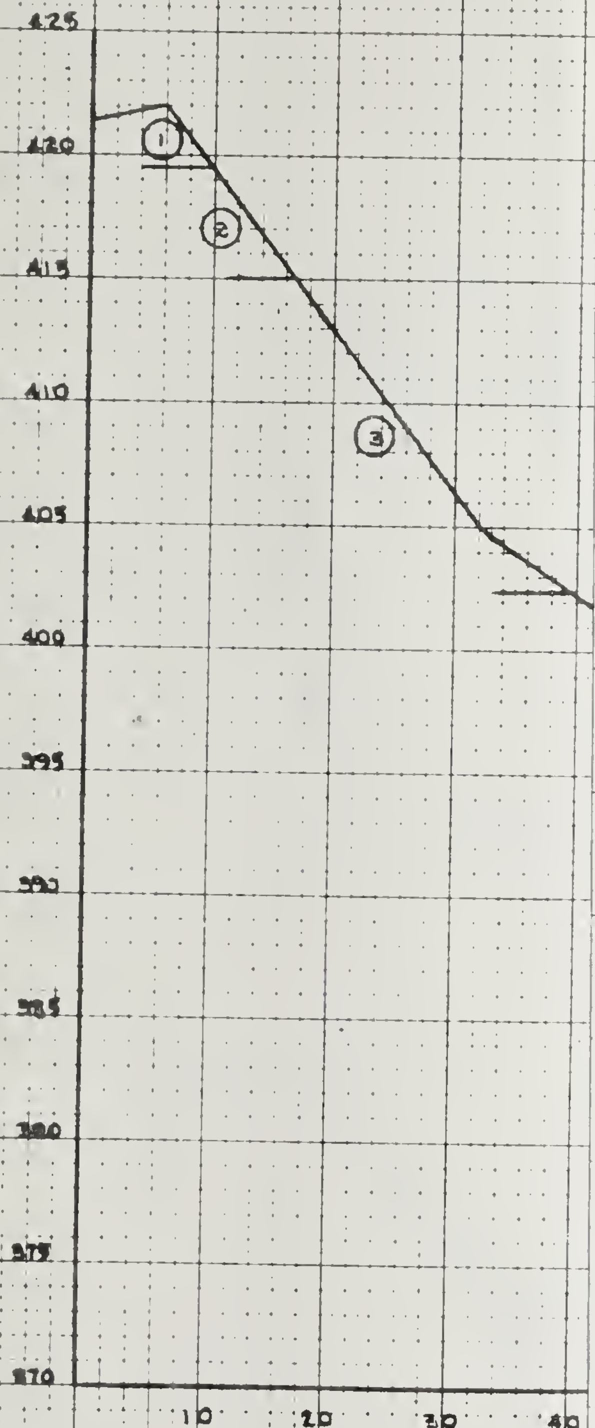
OHIO RIVER DIVISION
BANK EROSION STUDY

CANNELTON POOL

NICHOLAS PURCELL, ET UX-TRACTS 3229E & 3238E
PLAN
MILE 678.5

ORDXE JULY 77

PLATE 45



PURCELL

Tract 3229E & 3238E

1. SANDY SILTY CLAY, light brown, rootlets, damp
2. SANDY SILTY CLAY, mottled light brown to gray, blocky, iron staining, damp
3. SANDY SILTY CLAY, mottled light brown to gray, damp
4. COLLUVIUM, state of active failure
5. CLAY, light brown to gray, trace sand, wet
6. SANDY SILTY CLAY, gray to brown, wet
7. SILTY SANDY CLAY, brown, iron staining, wet
8. SILTY SANDY CLAY, brown, iron staining, sandstone fragments, auger refusal, wet

U.S. ARMY CORPS OF ENGINEERS

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BANK EROSION STUDY

CANNELTON POOL

NICHOLAS PURCELL, ET UX-TRACTS 3229E & 3238E

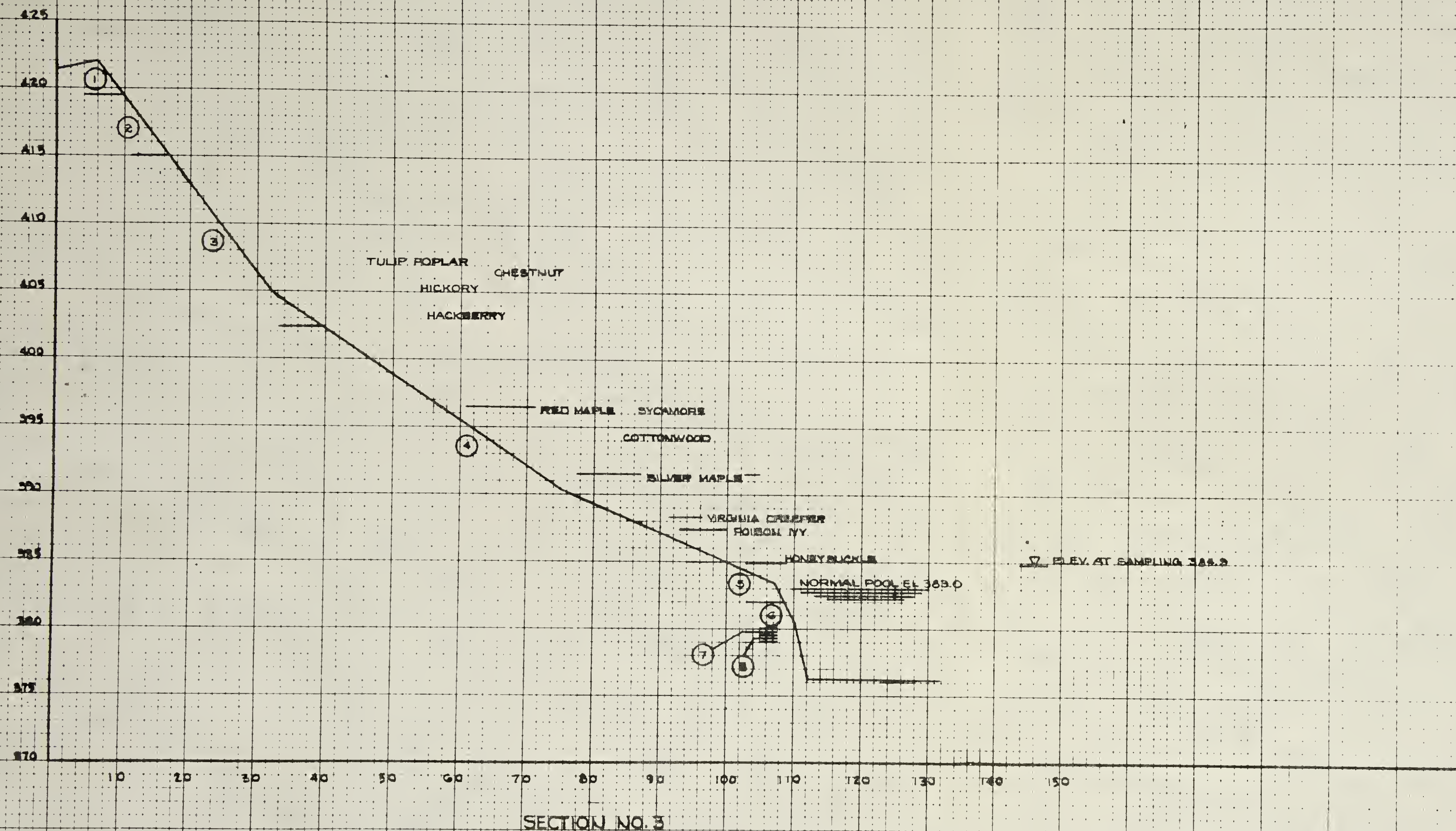
SOIL & VEGETATION PROFILE

MILE 678.5

ORDXE | JULY 77

PLATE 45

SHEET 2 OF 2



PURCELL

Tract 3229E & 3238E

1. SANDY SILTY CLAY, light brown, rootlets, damp
2. SANDY SILTY CLAY, mottled light brown to gray, blocky, iron staining, damp
3. SANDY SILTY CLAY, mottled light brown to gray, damp
4. COLLUVIUM, state of active failure
5. CLAY, light brown to gray, trace sand, wet
6. SANDY SILTY CLAY, gray to brown, wet
7. SILTY SANDY CLAY, brown, iron staining, wet
8. SILTY SANDY CLAY, brown, iron staining, sandstone fragments, auger refusal, wet

U.S. ARMY CORPS OF ENGINEERS

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BANK EROSION STUDY

CANNELTON POOL

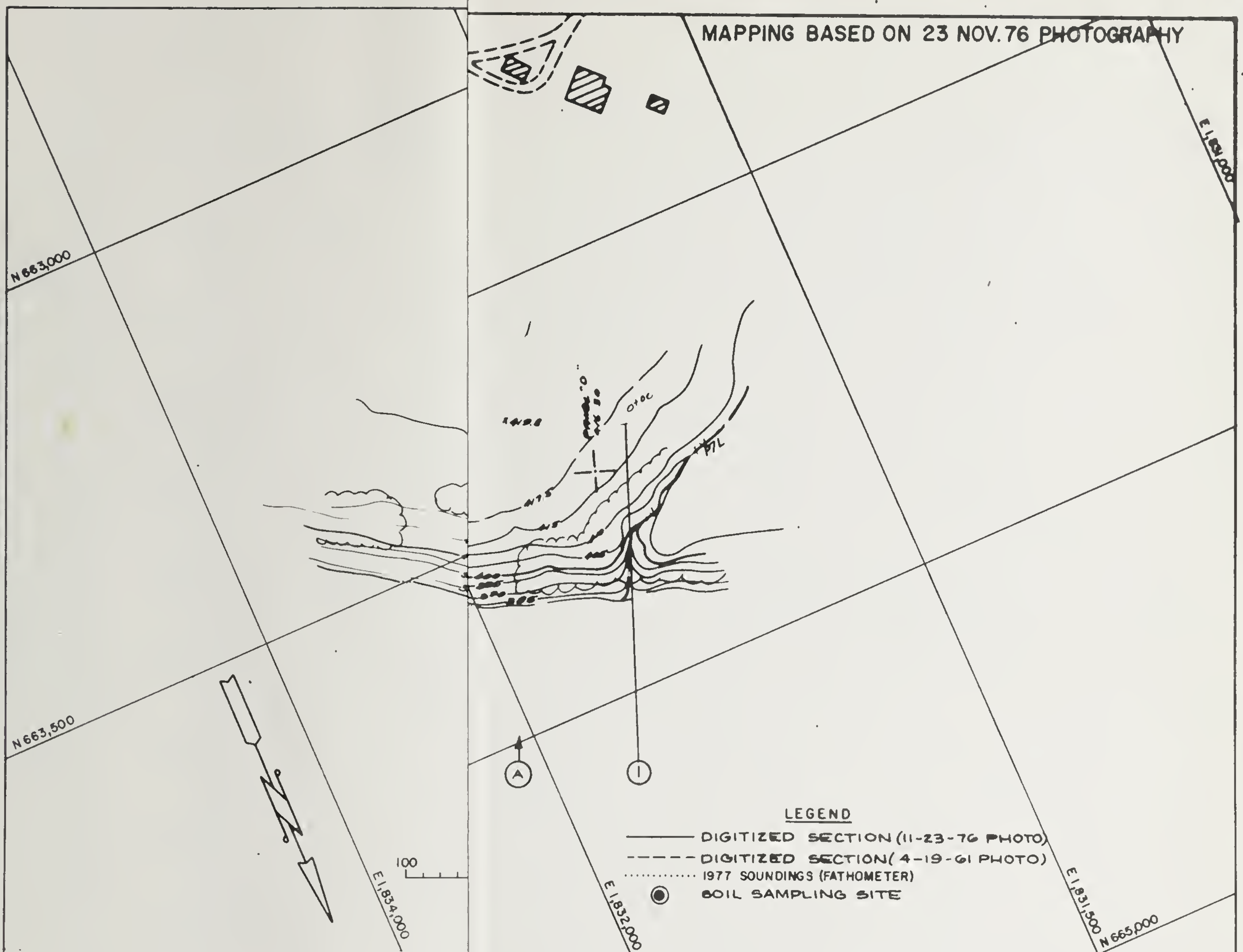
NICHOLAS PURCELL, ET UX-TRACTS 3229E & 3238E

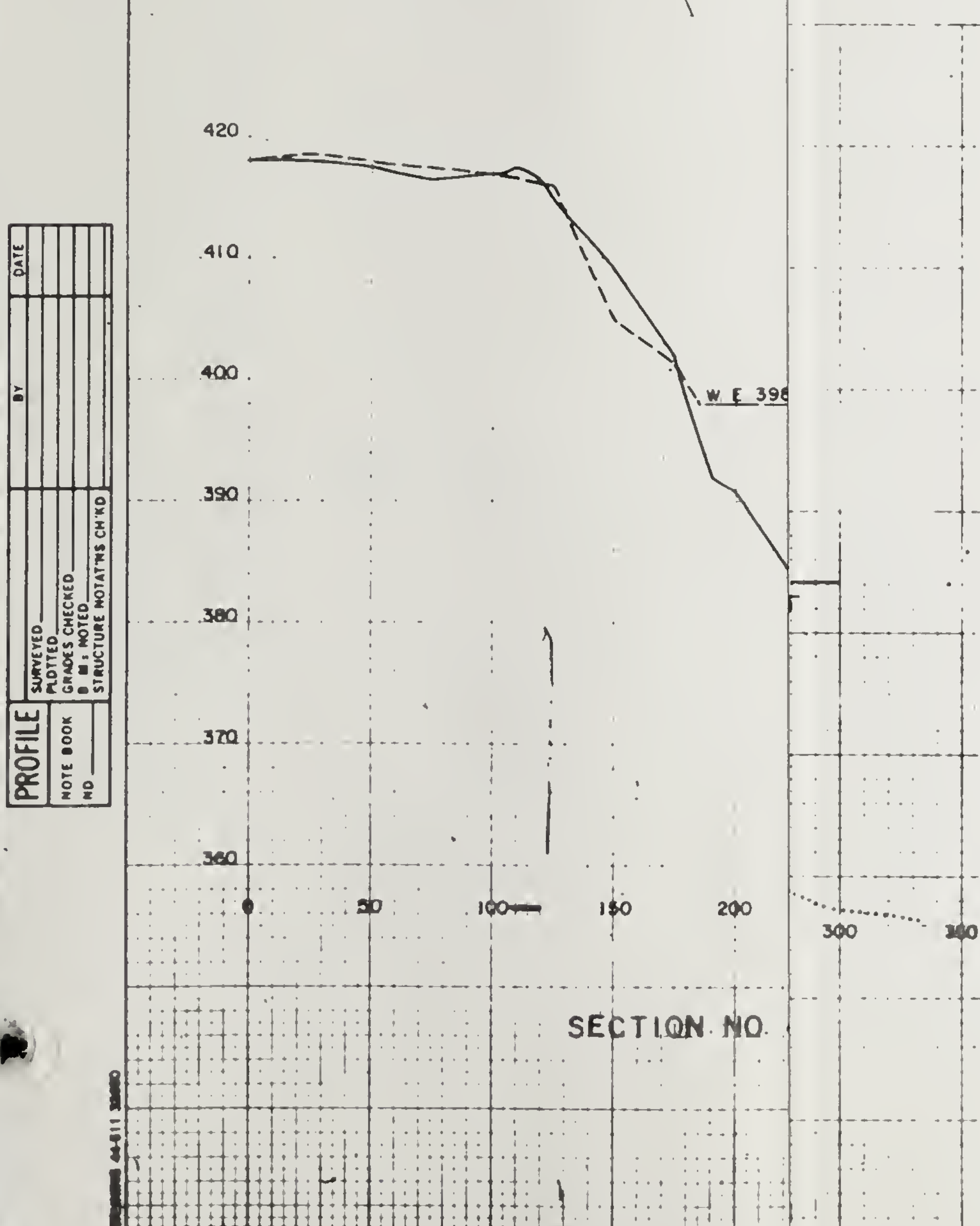
SOIL & VEGETATION PROFILE

MILE 678.5

ORDXE JULY 77

PLATE 45 SHEET 2 OF 2





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OHIO RIVER DIVISION

BANK EROSION STUDY

CANNELTON POOL

RALPH COX, ET UX, TRACT NO. 3703E

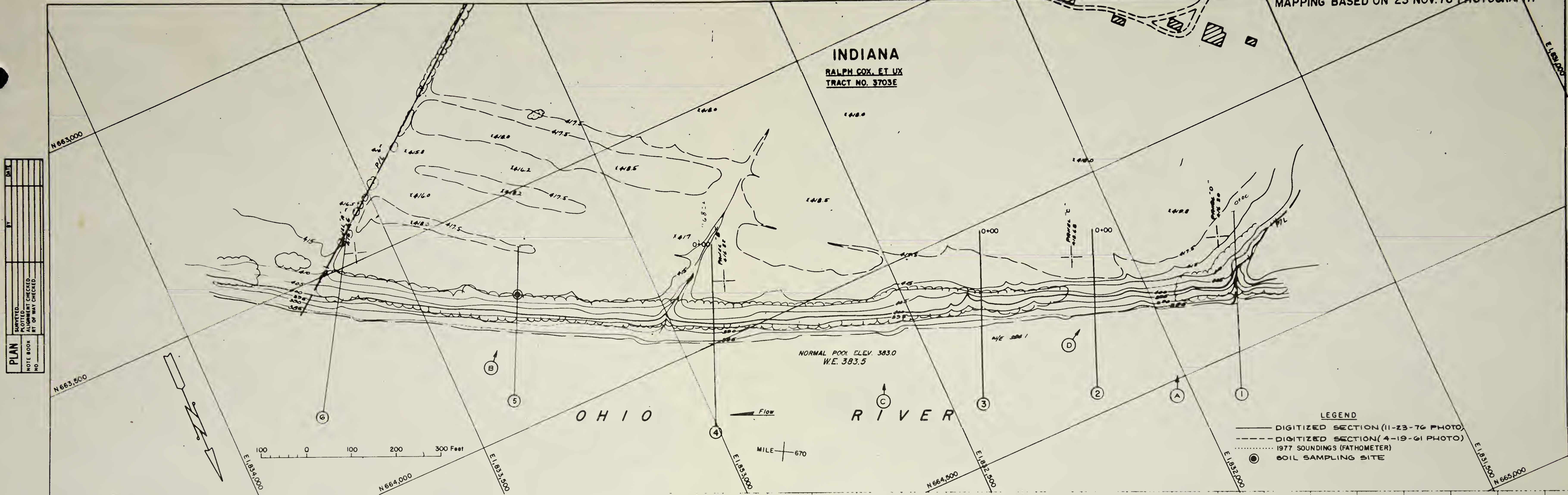
PLAN AND SECTIONS

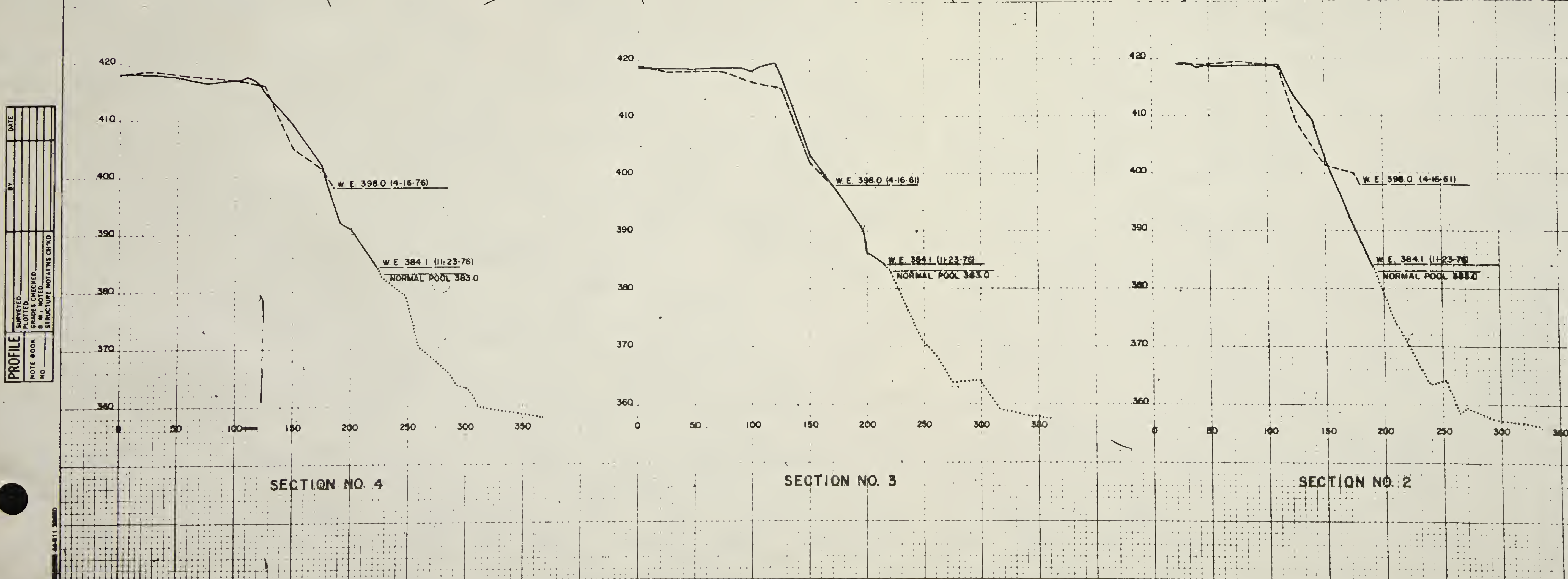
MILE 670.0

ORDXE JULY 77

PLATE 46

SHEET 1 OF 2





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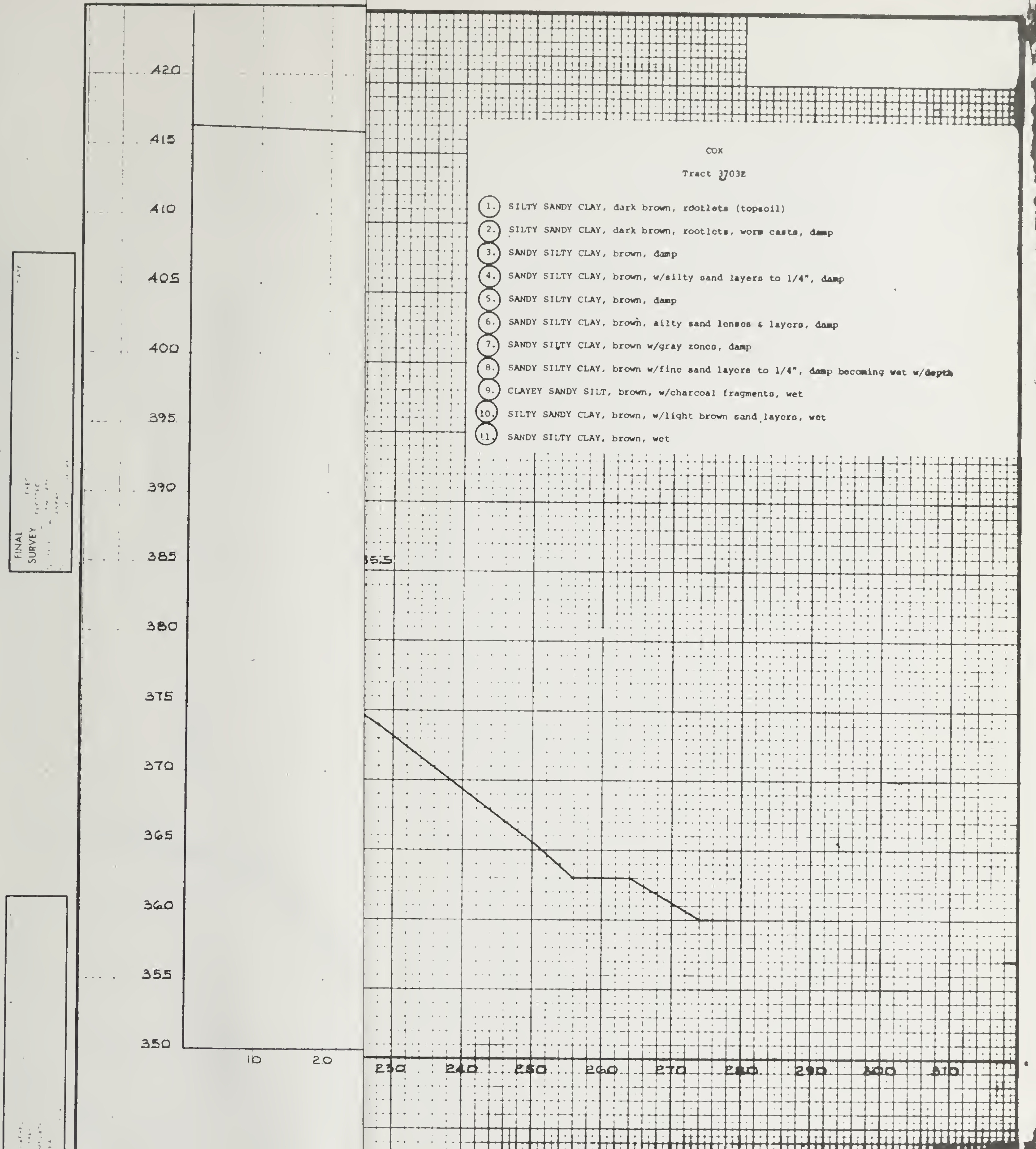
OHIO RIVER DIVISION
BANK EROSION STUDY

CANNELTON POOL

RALPH COX, ET UX, TRACT NO. 3703E
PLAN AND SECTIONS
MILE 670.0

ORDXE

JULY 77



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OHIO RIVER DIVISION

BANK EROSION STUDY

CANNELTON POOL

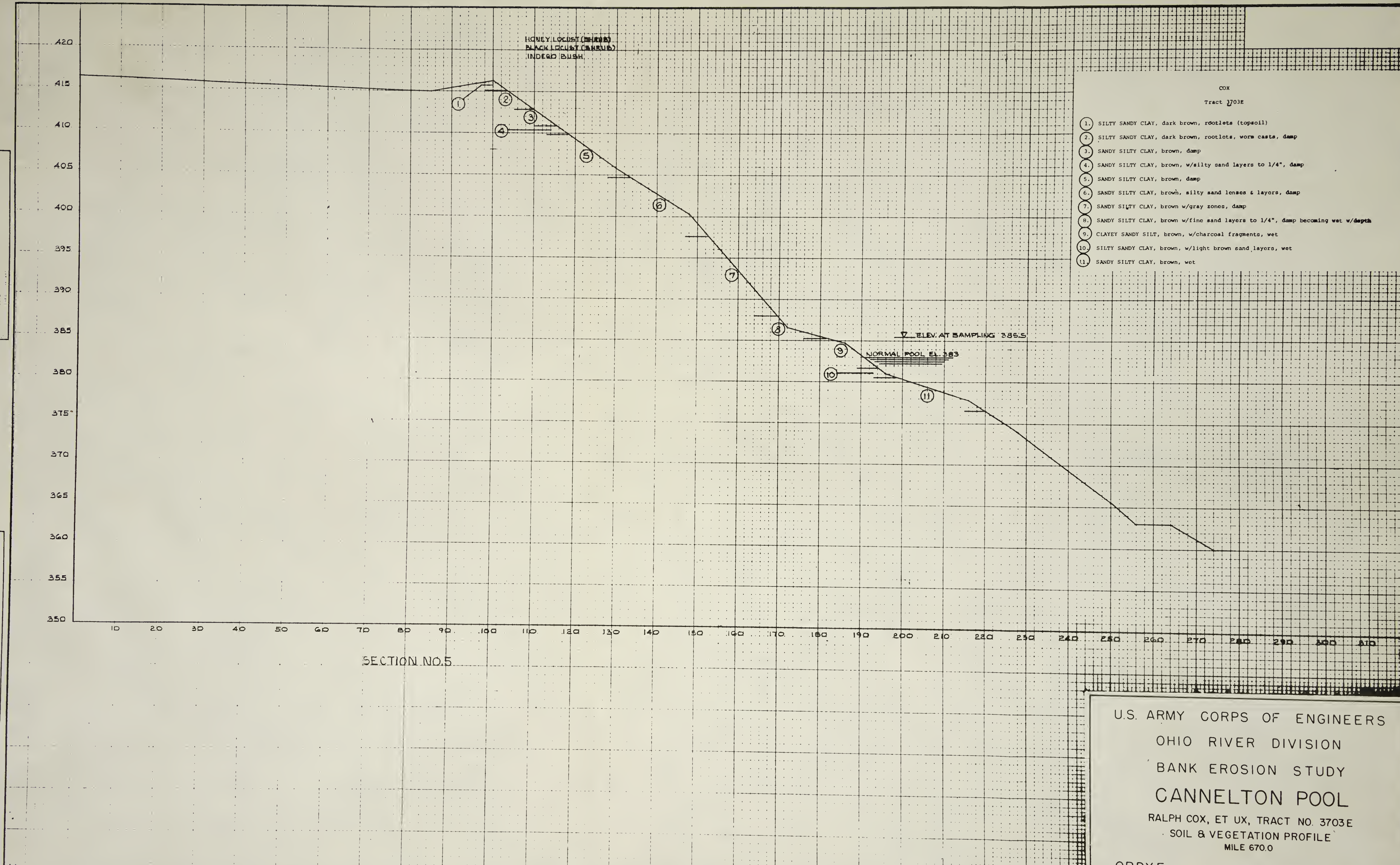
RALPH COX, ET UX, TRACT NO. 3703 E

SOIL & VEGETATION PROFILE

MILE 670.0

ORDXE JULY 77

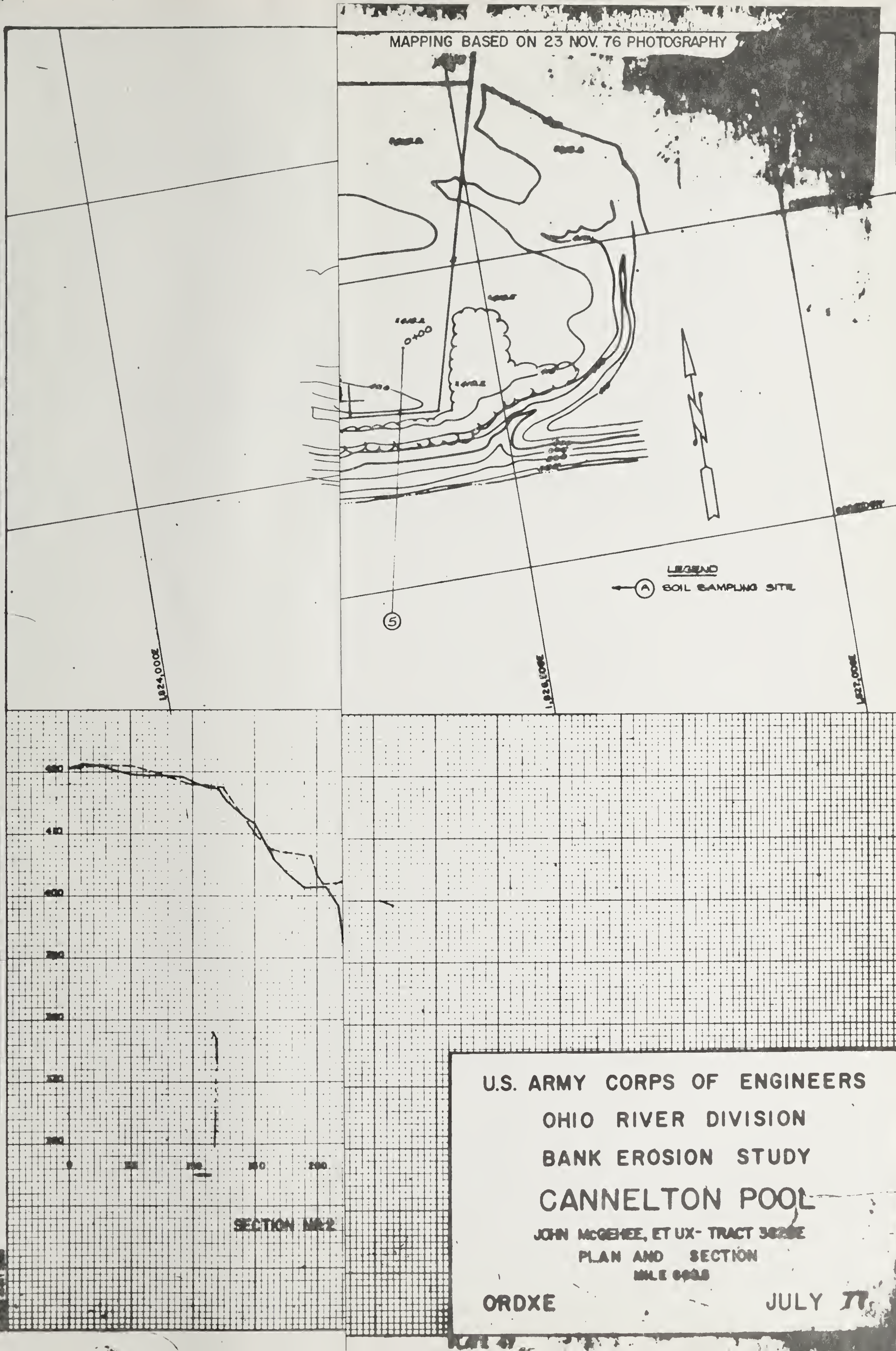
PLATE 46 REV. 7/15/77 SHEET 2 OF 2



U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY
CANNELTON POOL
RALPH COX, ET UX, TRACT NO. 3703E
SOIL & VEGETATION PROFILE
MILE 670.0

ORDXE JULY 77

PLATE 46 REV. 7/15/77 SHEET 2 OF 2


MAPPING BASED ON 23 NOV. 76 PHOTOGRAPHY
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LEGEND
(A) SOIL SAMPLING SITE
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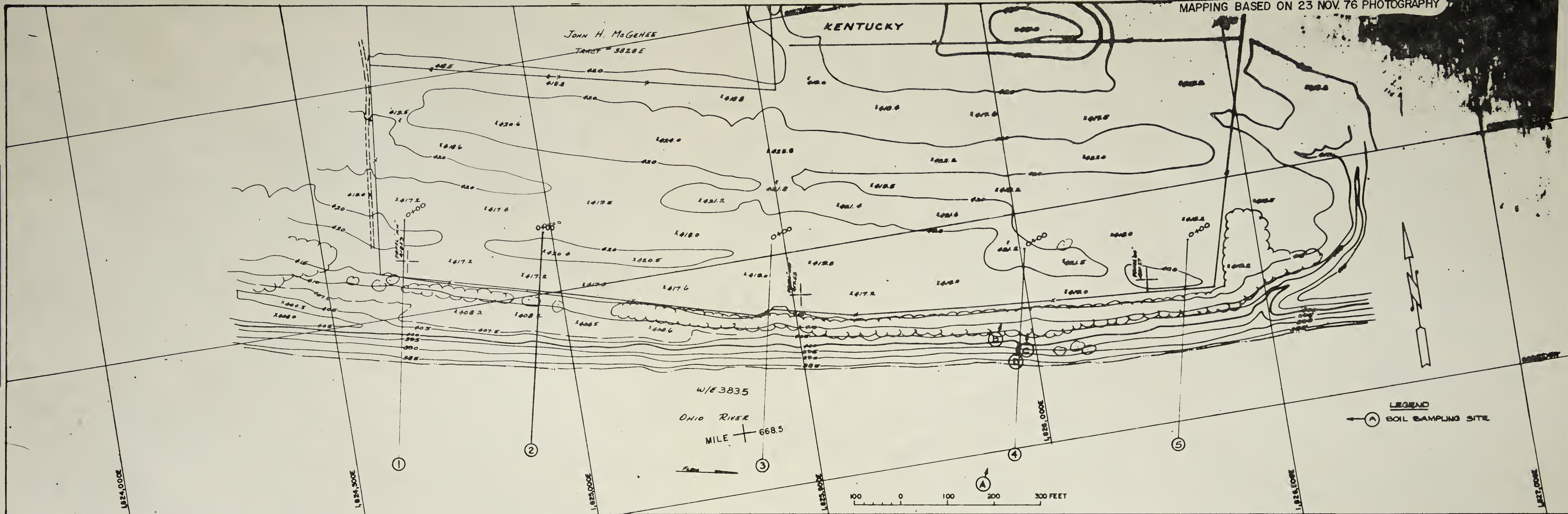
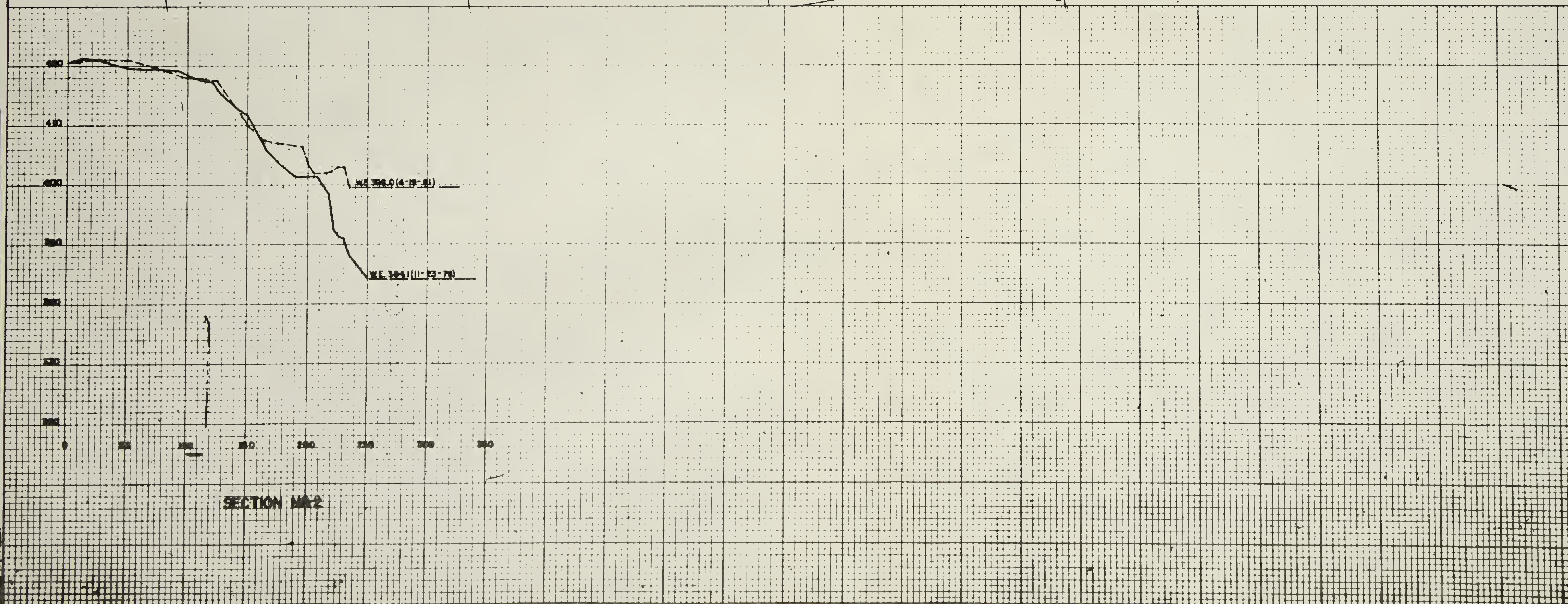
PLAN
PROFILE
SECTION NO.2
U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY
CANNELTON POOL
JOHN McGEHEE, ET UX- TRACT
PLAN AND SECTION
ORDXE
JULY 77





U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

CANNELTON POOL

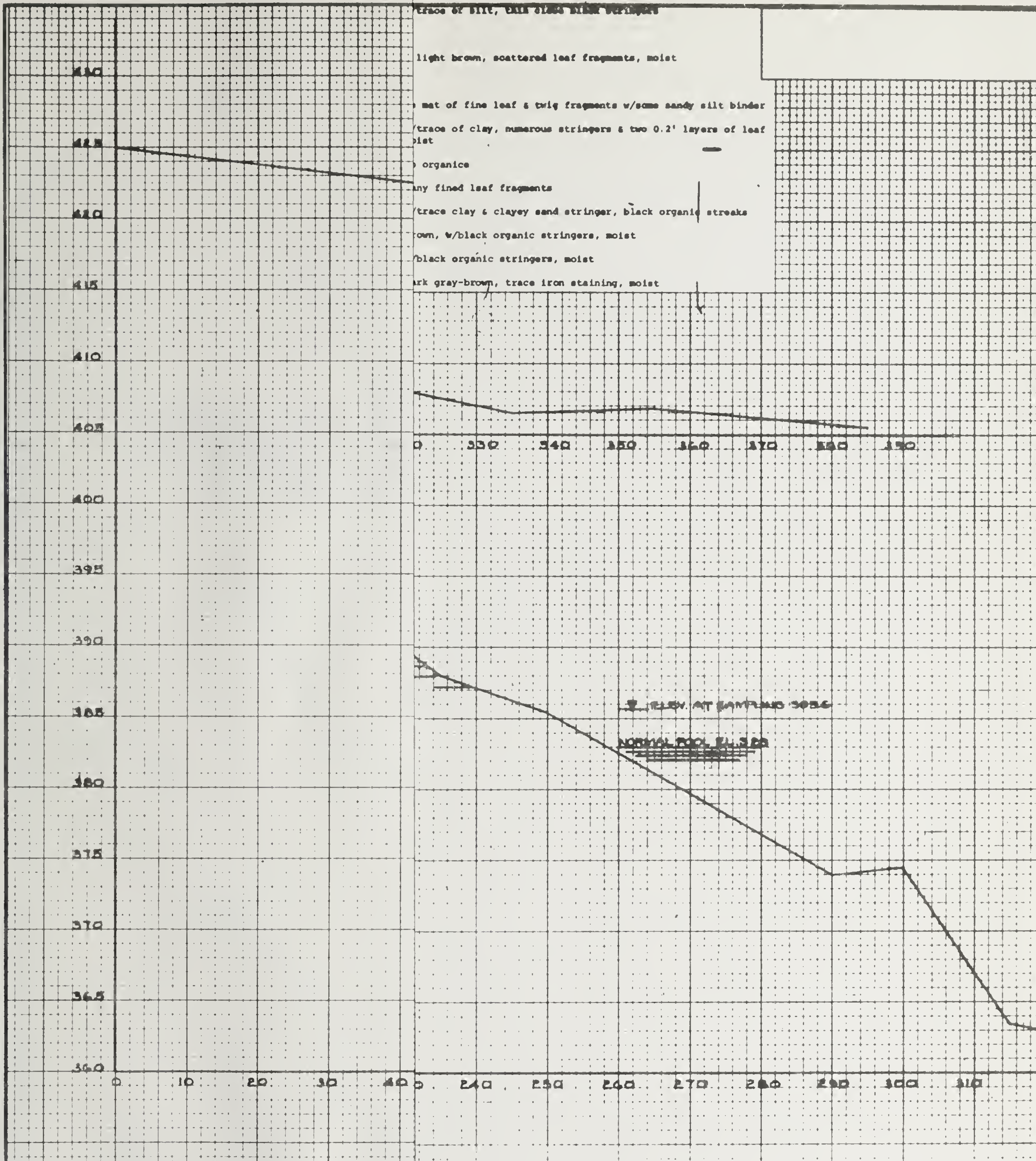
JOHN McGEHEE, ET UX- TRACT 3828E

PLAN AND SECTION

MILE 668.5

ORDXE

JULY 77



U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

CANNELTON POOL

JOHN H. McGEHEE, TRACT NO. 3828E

SOIL PROFILE

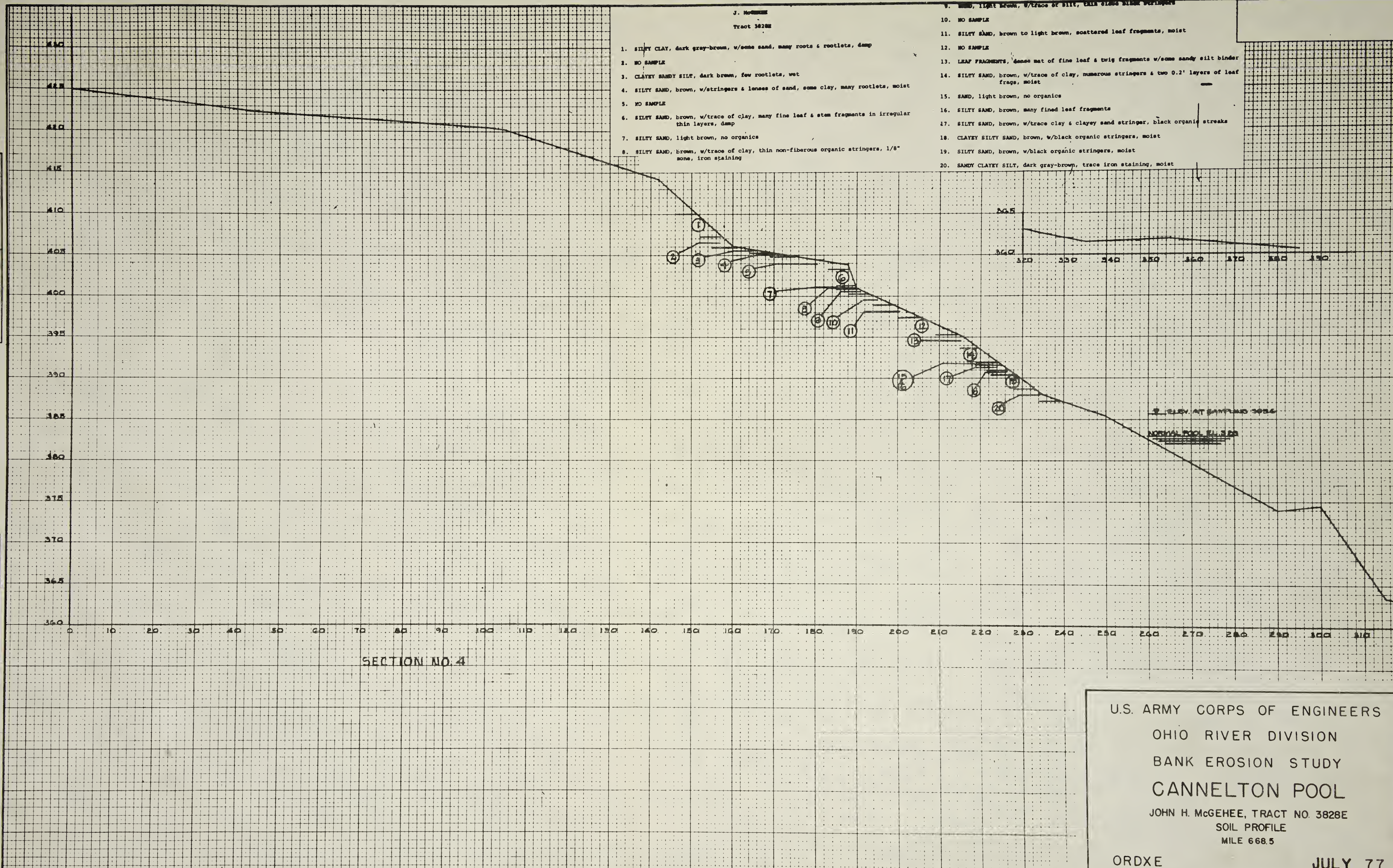
MILE 668.5

ORDXE JULY 77

J. McGEHEE

Tract 3828E

1. SILTY CLAY, dark gray-brown, w/some sand, many roots & rootlets, damp
2. NO SAMPLE
3. CLAYEY SANDY SILT, dark brown, few rootlets, wet
4. SILTY SAND, brown, w/stringers & lenses of sand, some clay, many rootlets, moist
5. NO SAMPLE
6. SILTY SAND, brown, w/trace of clay, many fine leaf & stem fragments in irregular thin layers, damp
7. SILTY SAND, light brown, no organics
8. SILTY SAND, brown, w/trace of clay, thin non-fiberous organic stringers, 1/8" zone, iron staining
9. SAND, light brown, w/trace of silt, [illegible]
10. NO SAMPLE
11. SILTY SAND, brown to light brown, scattered leaf fragments, moist
12. NO SAMPLE
13. LEAF FRAGMENTS, dense mat of fine leaf & twig fragments w/some sandy silt binder
14. SILTY SAND, brown, w/trace of clay, numerous stringers & two 0.2' layers of leaf frags, moist
15. SAND, light brown, no organics
16. SILTY SAND, brown, many fined leaf fragments
17. SILTY SAND, brown, w/trace clay & clayey sand stringer, black organic streaks
18. CLAYEY SILTY SAND, brown, w/black organic stringers, moist
19. SILTY SAND, brown, w/black organic stringers, moist
20. SANDY CLAYEY SILT, dark gray-brown, trace iron staining, moist



FINAL SURVEY | DATE | BY | NOTE BOOK | NO. | SURVEYED | PLOTTED | TEMPLATE | AREAS | AREAS CHECKED

ORIGINAL SURVEY | DATE | BY | NOTE BOOK | NO. | SURVEYED | PLOTTED | TEMPLATE | AREAS | AREAS CHECKED

U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY

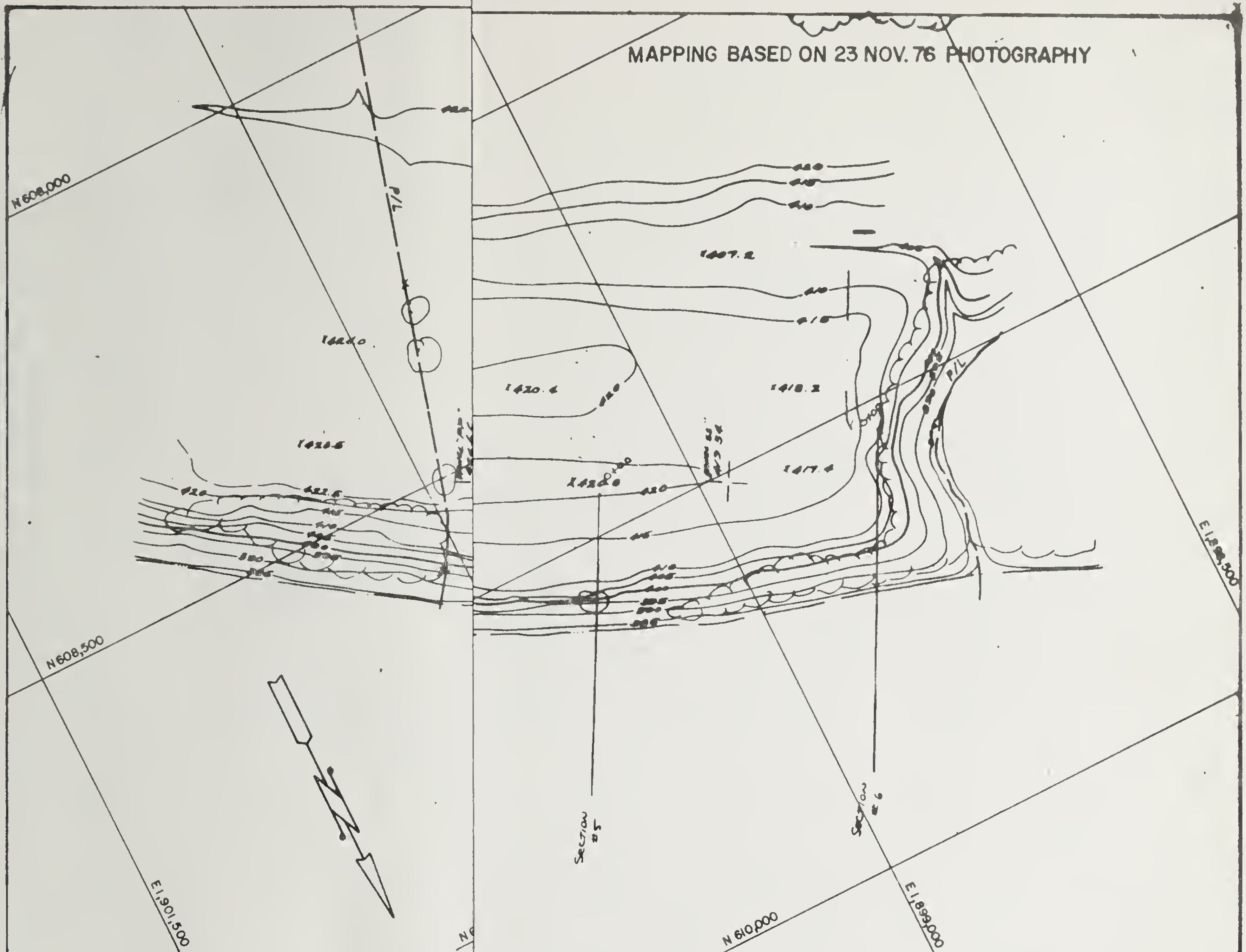
CANNELTON POOL

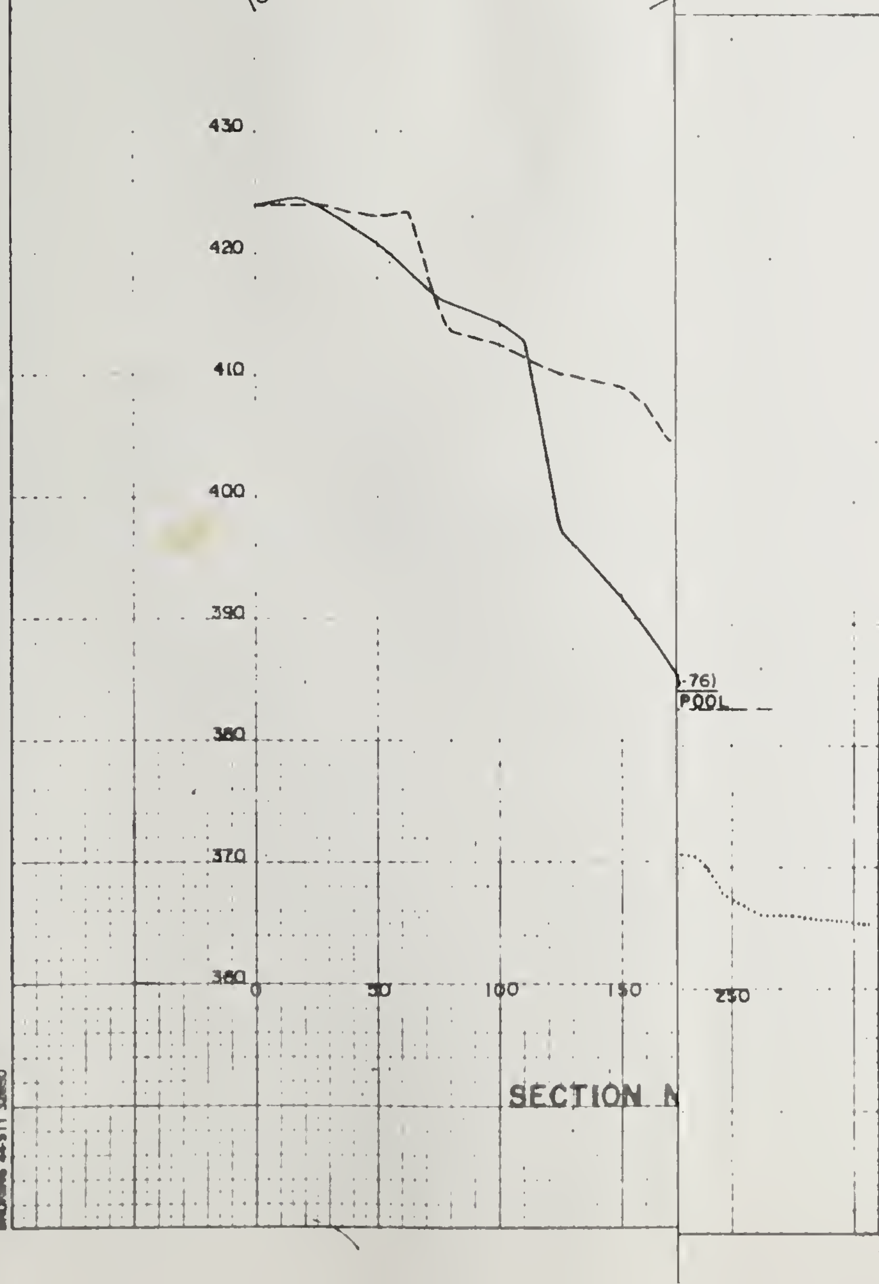
JOHN H. McGEHEE, TRACT NO. 3828E
SOIL PROFILE
MILE 668.5

ORDXE JULY 77

PLATE 47

SHEET 2 OF 2





U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

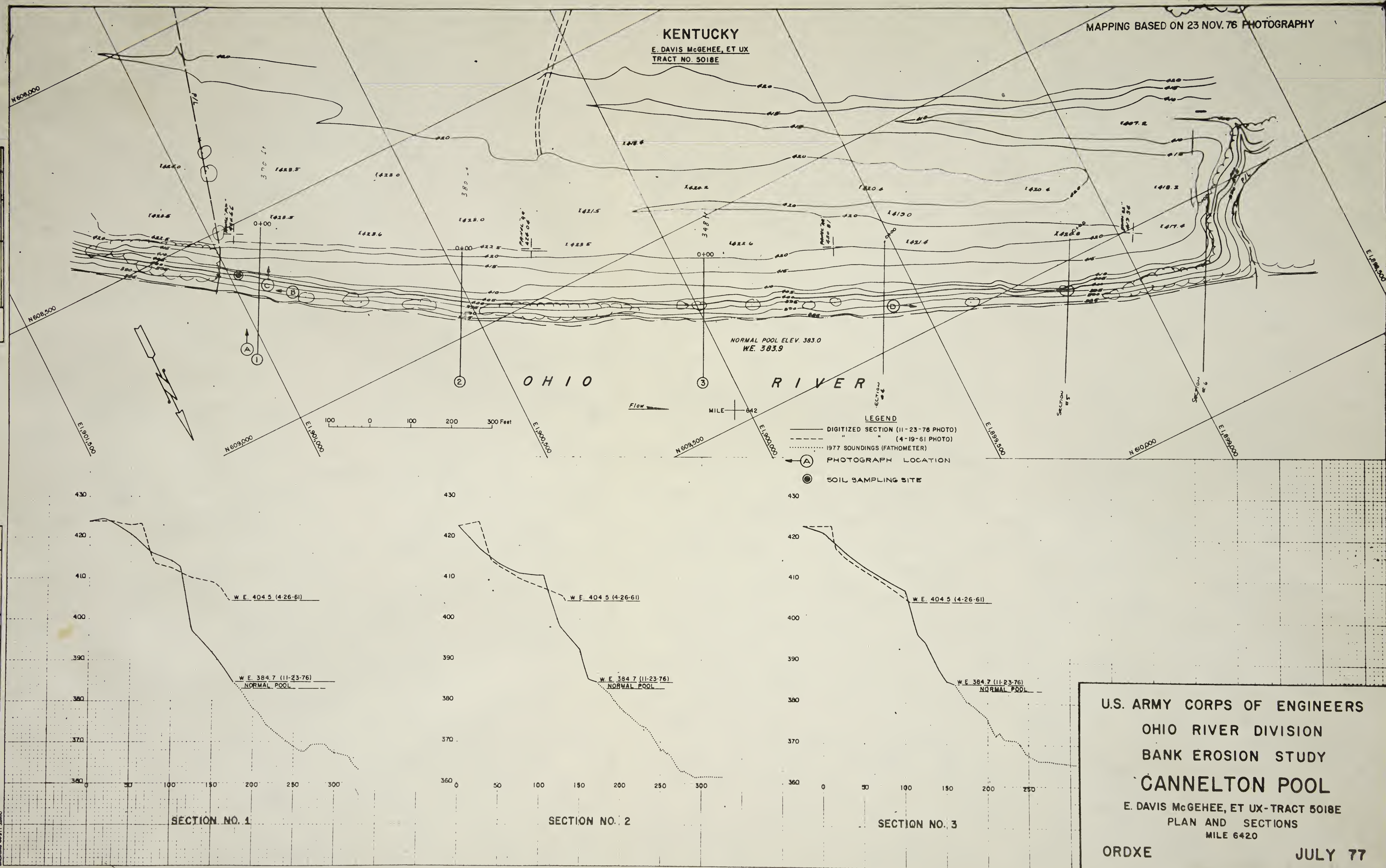
CANNELTON POOL

E. DAVIS McGEHEE, ET UX-TRACT 5018E

PLAN AND SECTIONS

MILE 642.0

ORDXE JULY 77

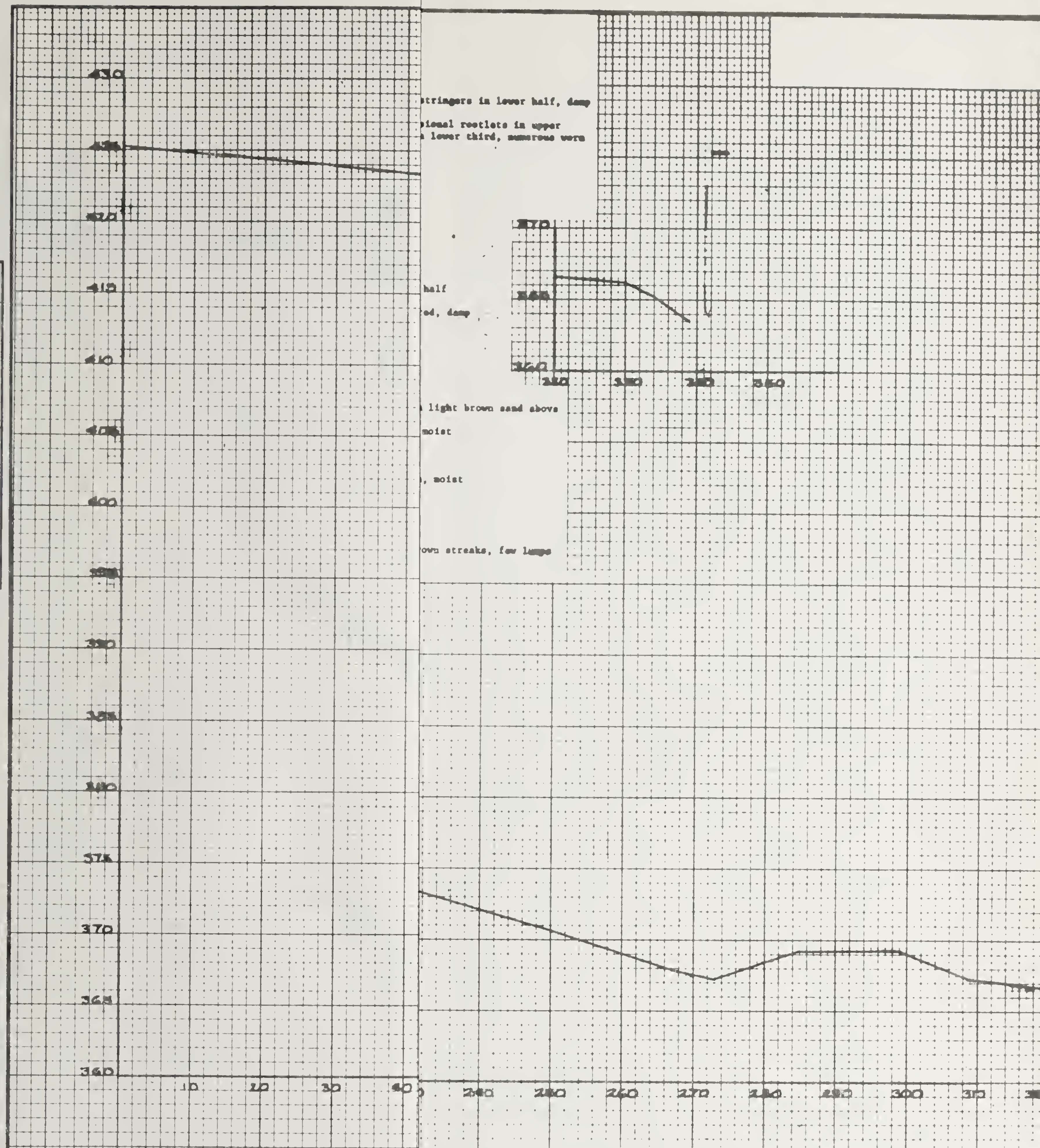


U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY
CANNELTON POOL
E. DAVIS McGEHEE, ET UX-TRACT 5018E
PLAN AND SECTIONS
MILE 642.0

ORDXE JULY 77

PLATE 48

SHEET 1 OF 2



U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

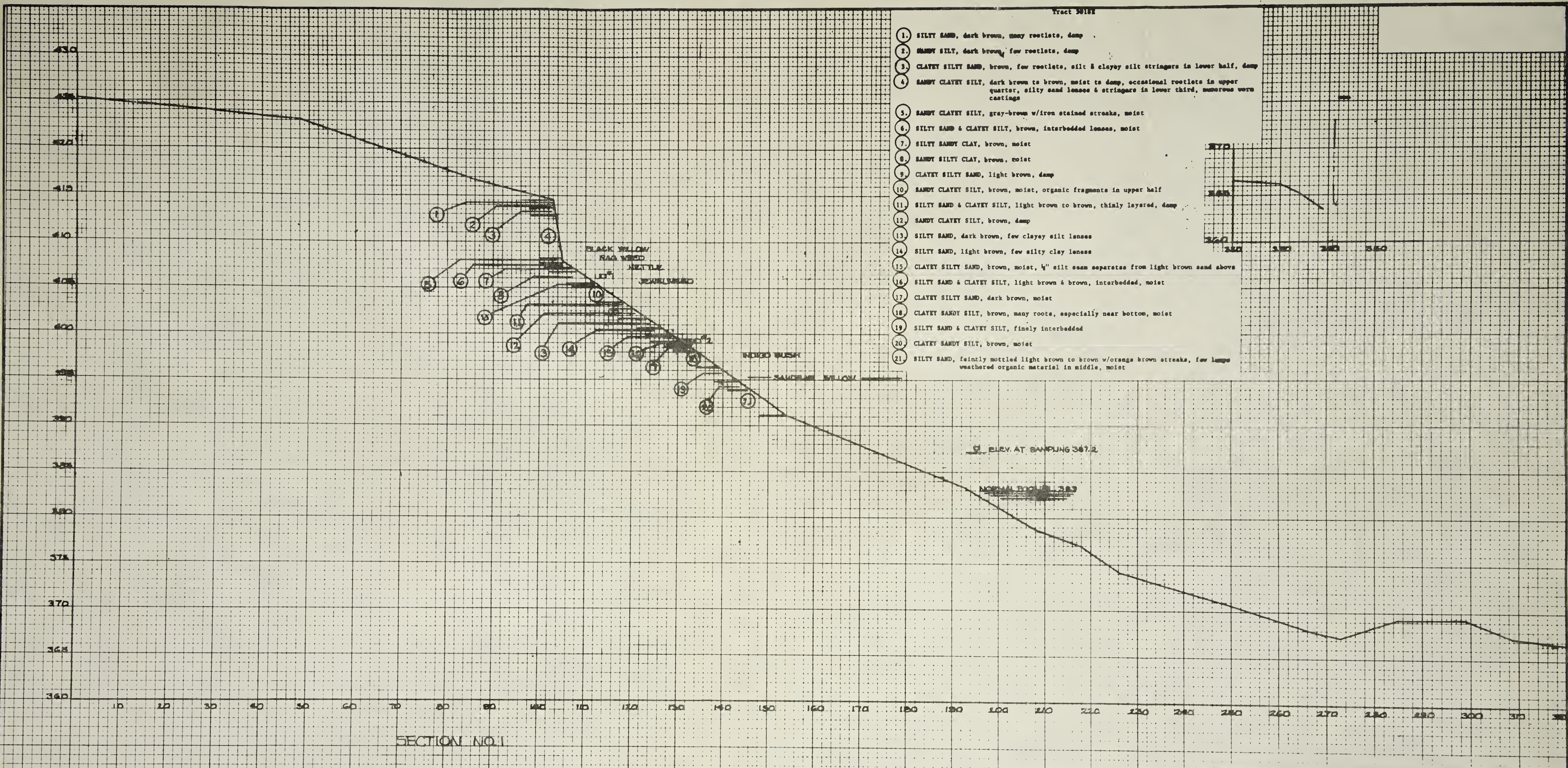
CANNELTON POOL

E. DAVIS McGEHEE, ET UX - TRACT 5018

SOIL & VEGETATION PROFILE

MILE 642.0

ORDXE JULY 77



Tract 5018

1. SILTY SAND, dark brown, many rootlets, damp
2. SANDY SILT, dark brown, few rootlets, damp
3. CLAYEY SILTY SAND, brown, few rootlets, silt & clayey silt stringers in lower half, damp
4. SANDY CLAYEY SILT, dark brown to brown, moist to damp, occasional rootlets in upper quarter, silty sand lenses & stringers in lower third, numerous worm castings
5. SANDY CLAYEY SILT, gray-brown w/iron stained streaks, moist
6. SILTY SAND & CLAYEY SILT, brown, interbedded lenses, moist
7. SILTY SANDY CLAY, brown, moist
8. SANDY SILTY CLAY, brown, moist
9. CLAYEY SILTY SAND, light brown, damp
10. SANDY CLAYEY SILT, brown, moist, organic fragments in upper half
11. SILTY SAND & CLAYEY SILT, light brown to brown, thinly layered, damp
12. SANDY CLAYEY SILT, brown, damp
13. SILTY SAND, dark brown, few clayey silt lenses
14. SILTY SAND, light brown, few silty clay lenses
15. CLAYEY SILTY SAND, brown, moist, ¼" silt seam separates from light brown sand above
16. SILTY SAND & CLAYEY SILT, light brown & brown, interbedded, moist
17. CLAYEY SILTY SAND, dark brown, moist
18. CLAYEY SANDY SILT, brown, many roots, especially near bottom, moist
19. SILTY SAND & CLAYEY SILT, finely interbedded
20. CLAYEY SANDY SILT, brown, moist
21. SILTY SAND, faintly mottled light brown to brown w/orange brown streaks, few large weathered organic material in middle, moist

U.S. ARMY CORPS OF ENGINEERS
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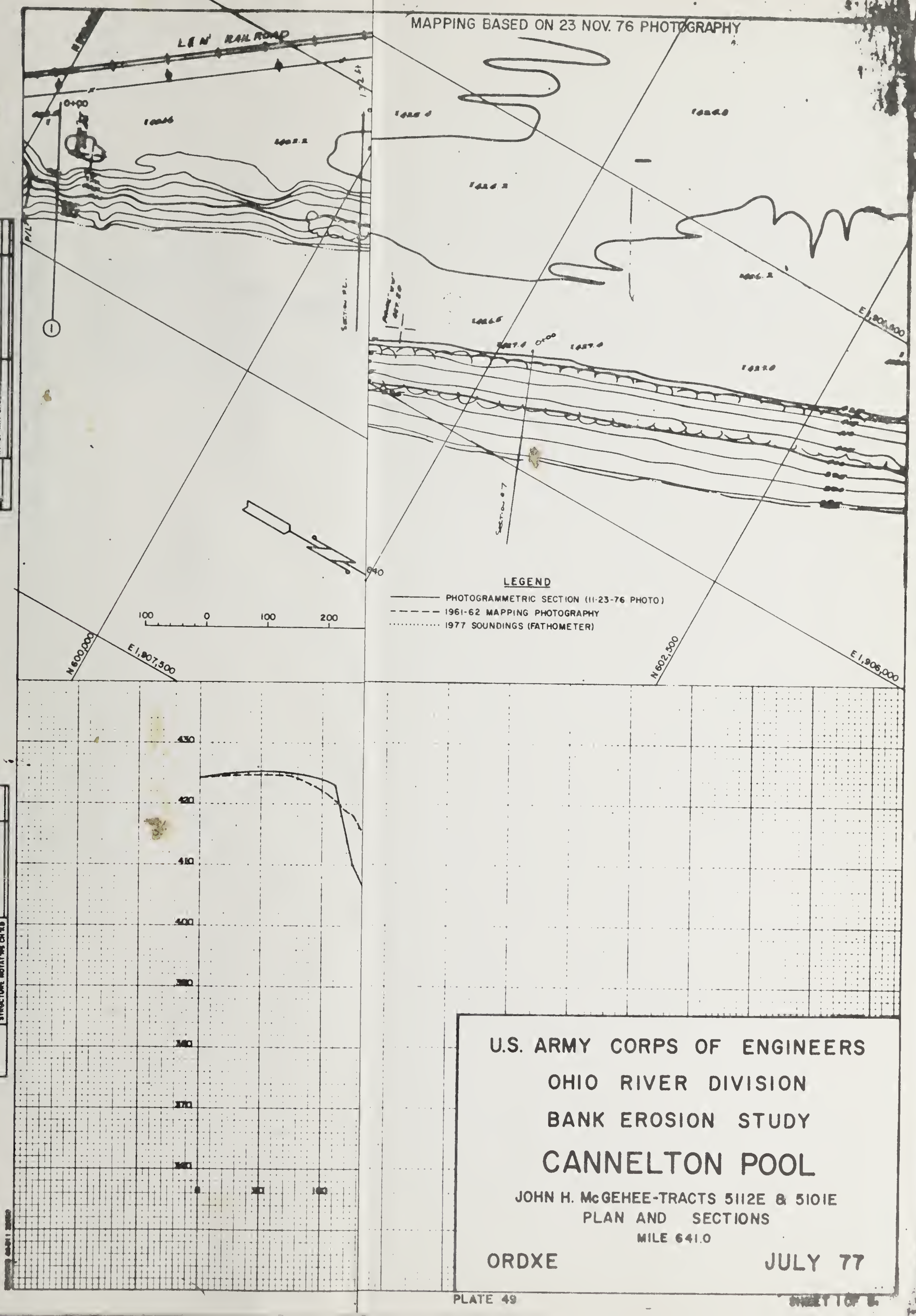
BANK EROSION STUDY

CANNELTON POOL

E. DAVIS McGEHEE, ET UX - TRACT 5018
SOIL & VEGETATION PROFILE
MILE 642.0

ORDXE JULY 77

PLATE 48



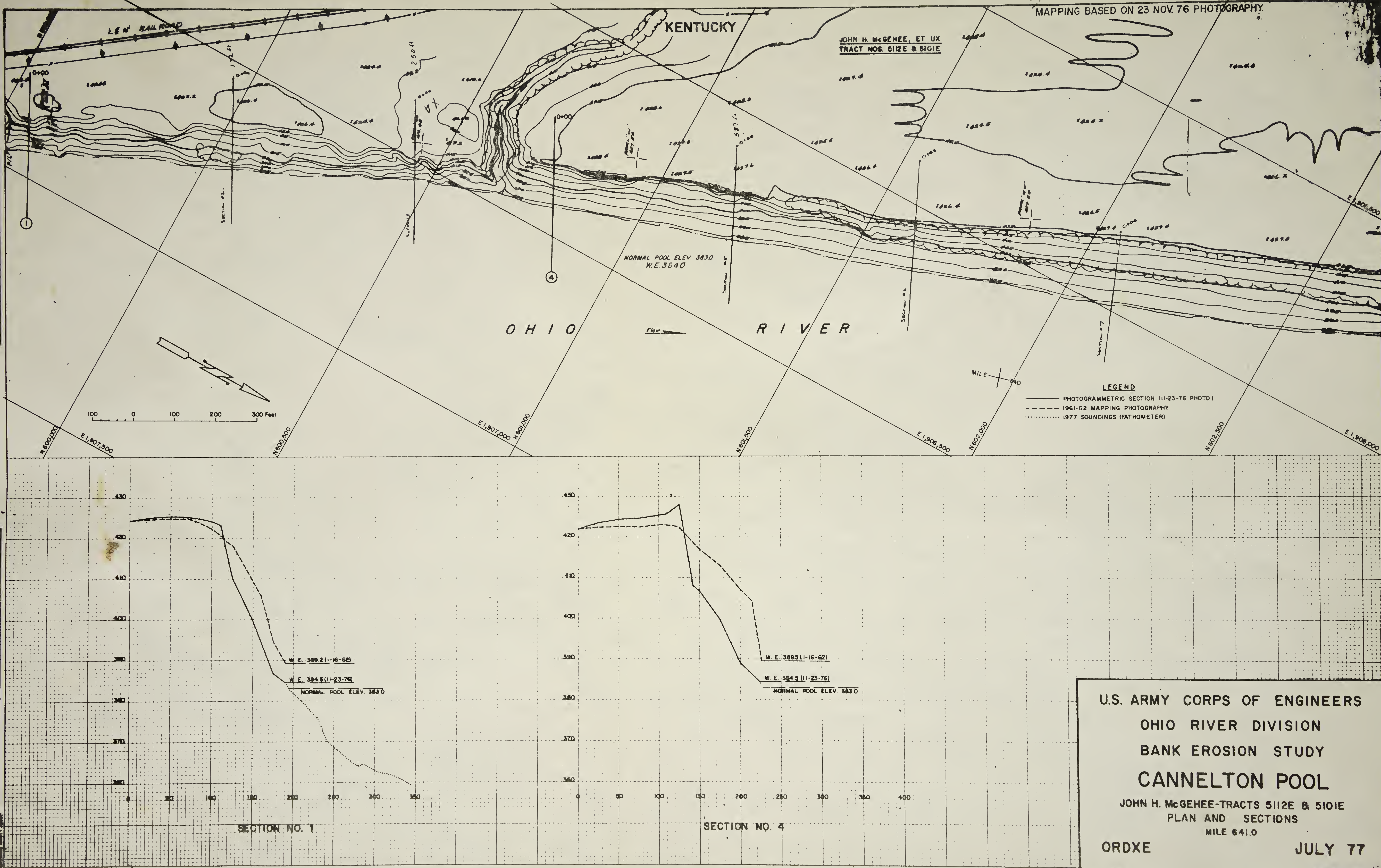
U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY

CANNELTON POOL

JOHN H. McGEHEE-TRACTS 5112E & 5101E
PLAN AND SECTIONS
MILE 641.0

ORDXE JULY 77

PLATE 49



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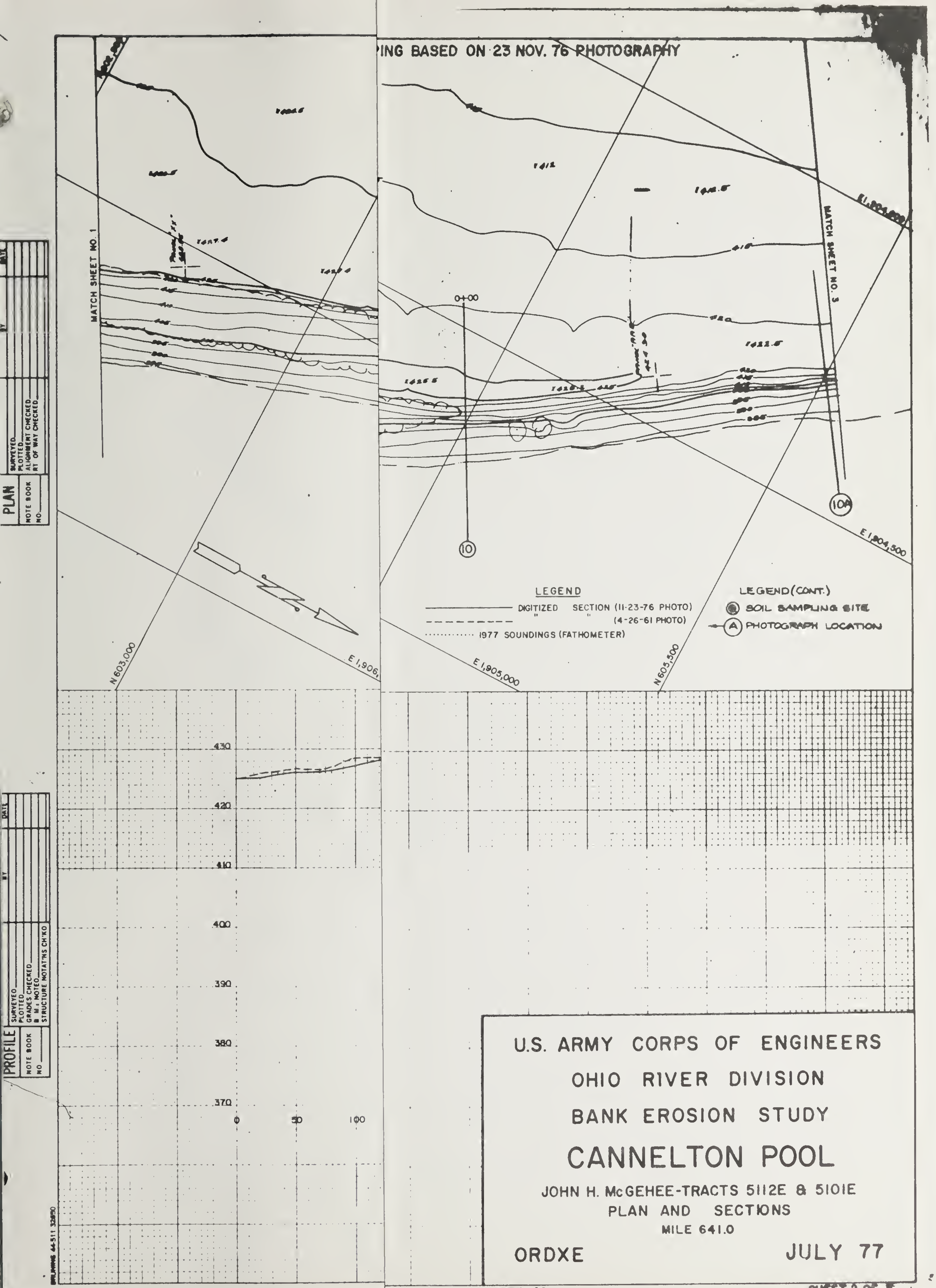
OHIO RIVER DIVISION
BANK EROSION STUDY

CANNELTON POOL

JOHN H. McGEHEE-TRACTS 5112E & 5101E
PLAN AND SECTIONS
MILE 641.0

ORDXE JULY 77

PLATE 49

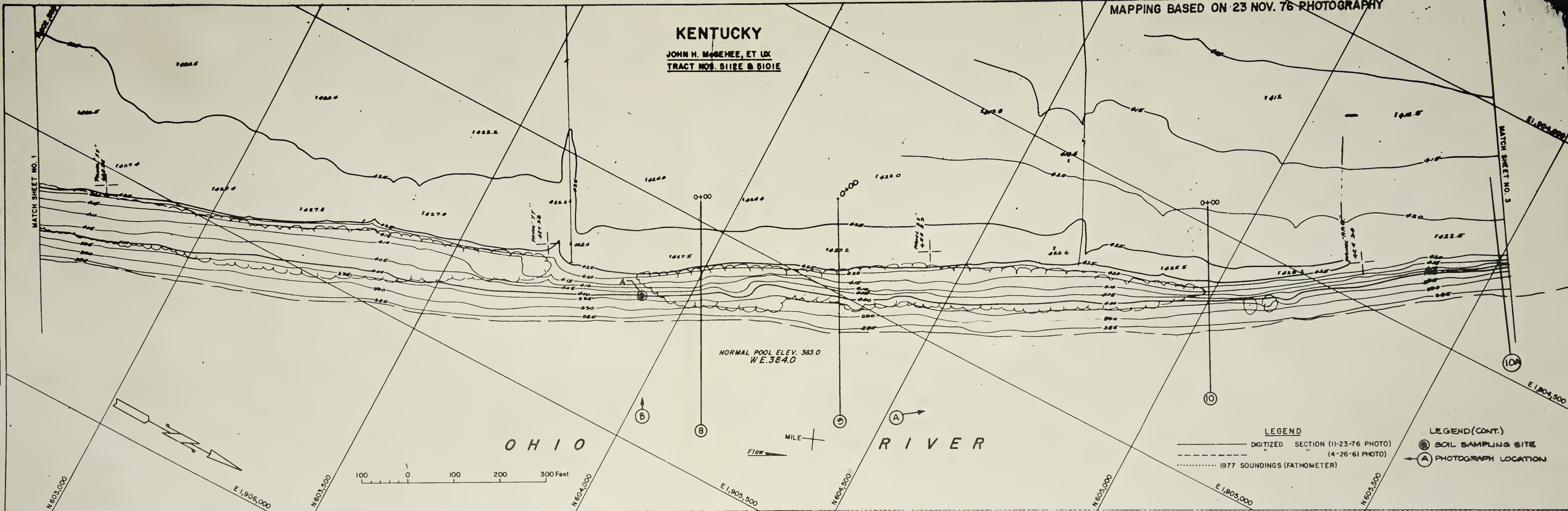


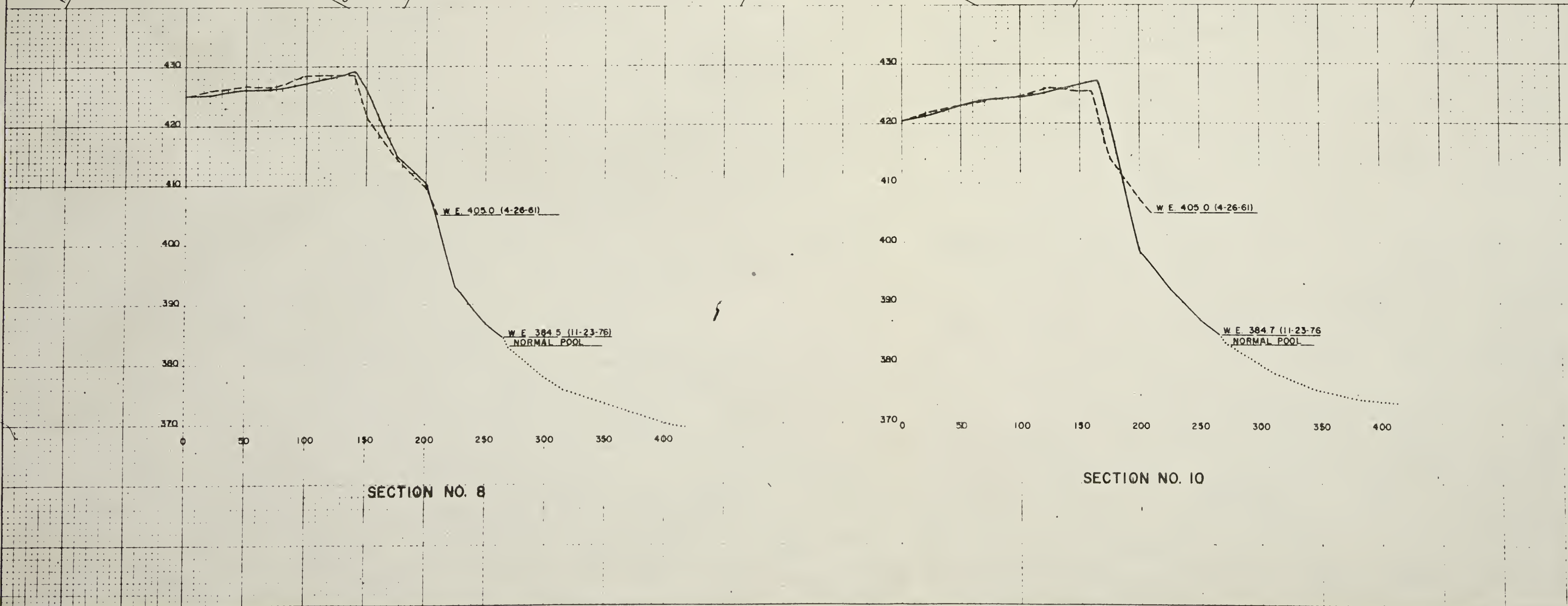
U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY

CANNELTON POOL

JOHN H. McGEHEE-TRACTS 5112E & 5101E
PLAN AND SECTIONS
MILE 641.0

ORDXE JULY 77





U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY

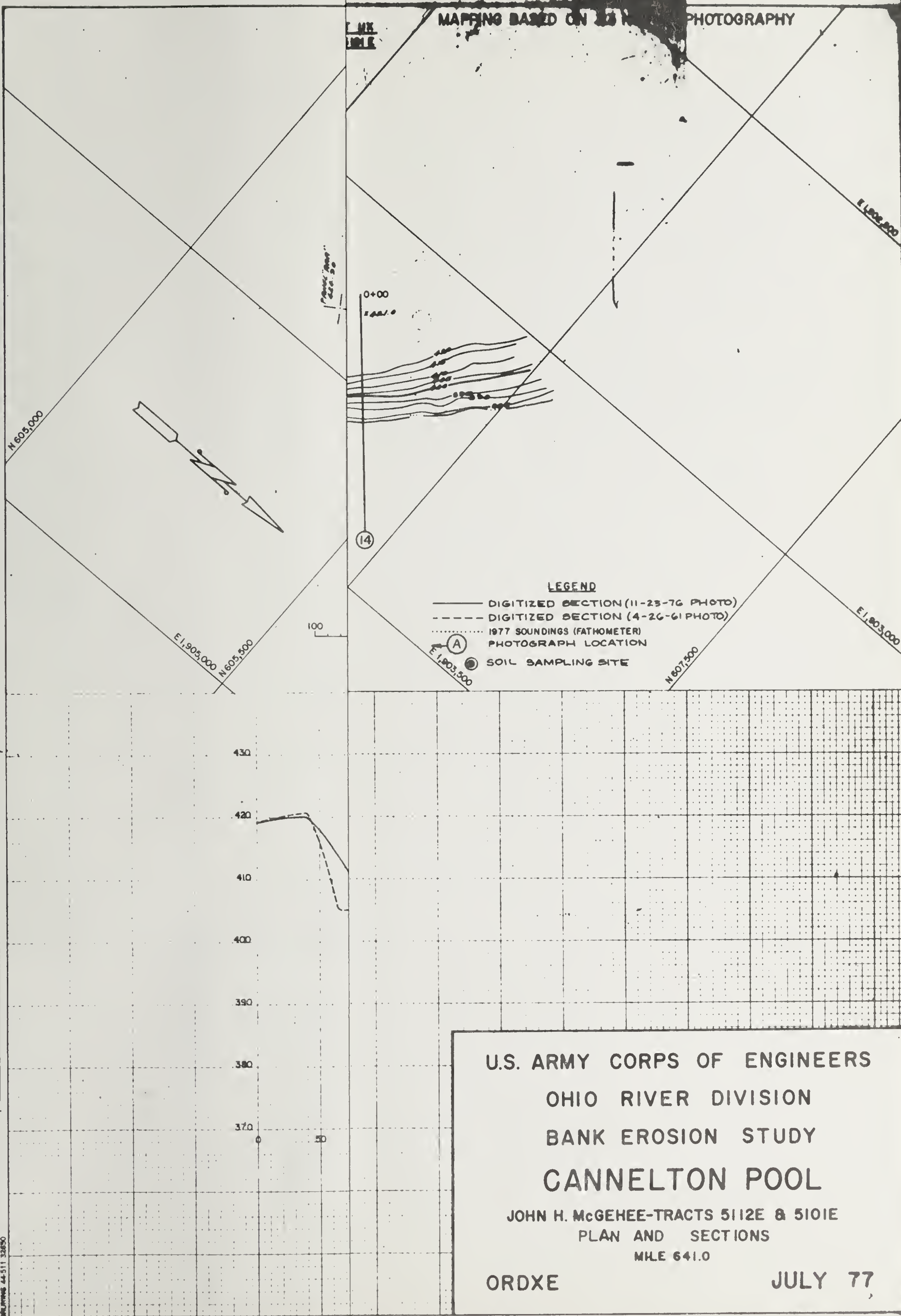
CANNELTON POOL

JOHN H. McGEHEE-TRACTS 5112E & 5101E
PLAN AND SECTIONS
MILE 641.0

ORDXE JULY 77

PLATE 49

SHEET 2 OF 5



U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

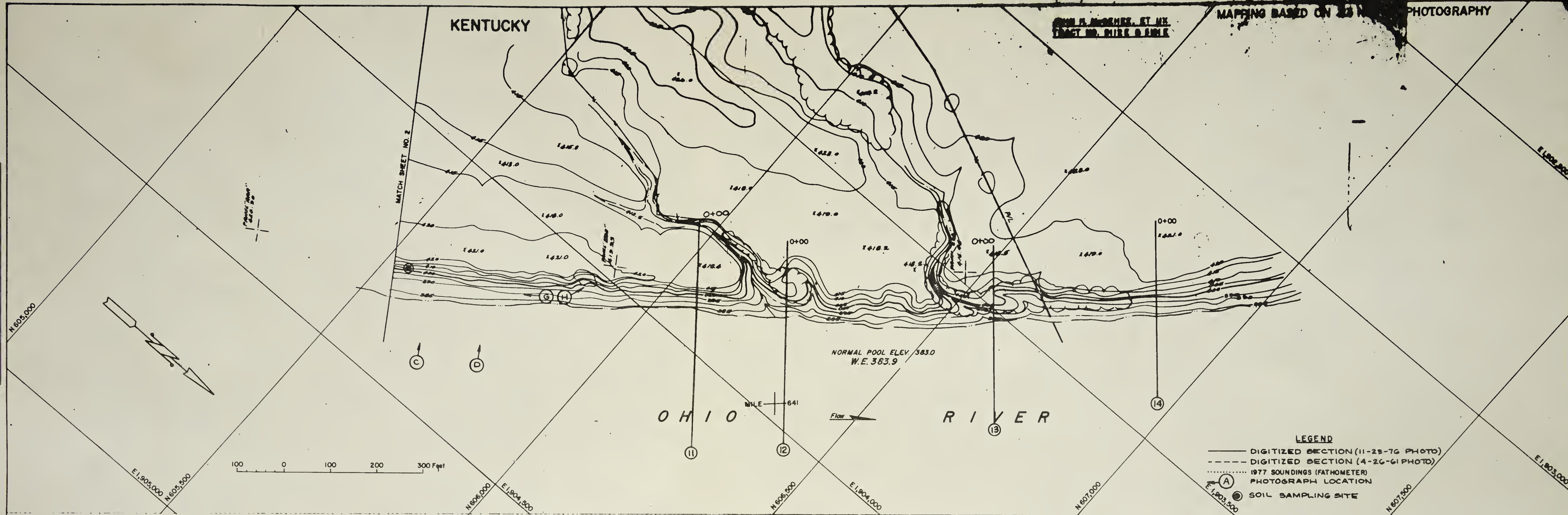
CANNELTON POOL

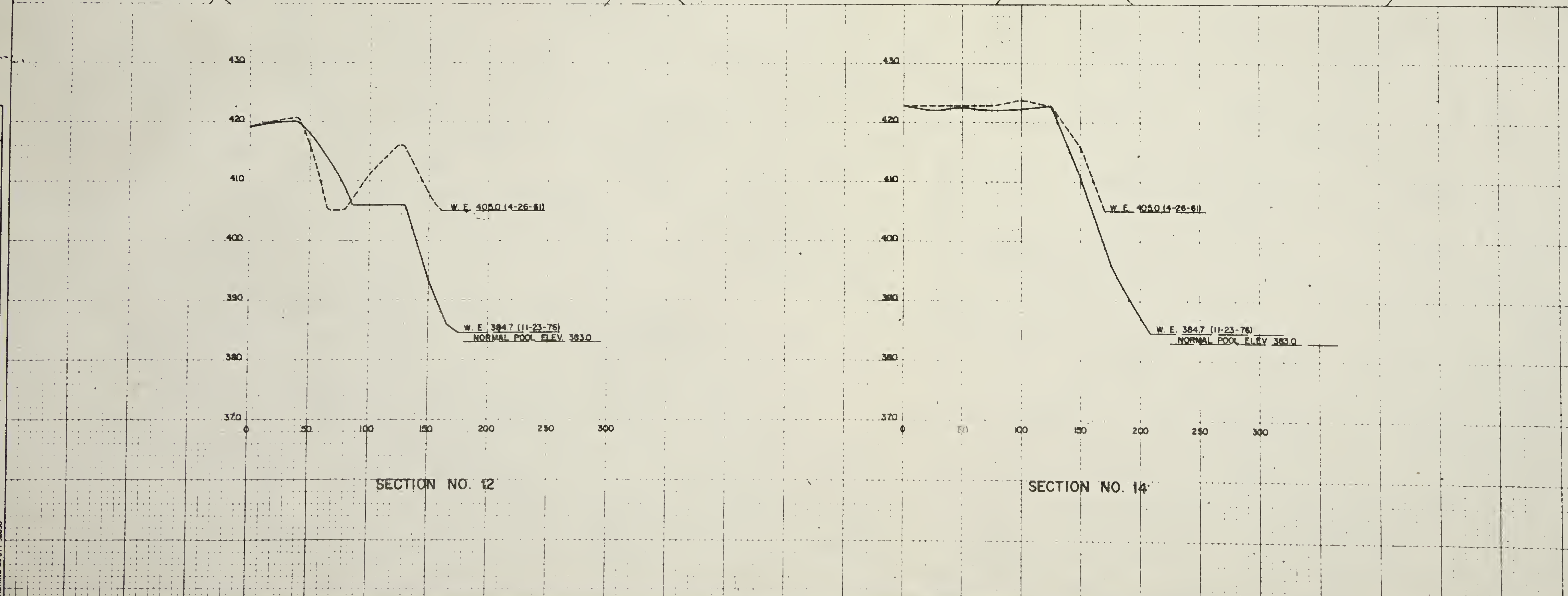
JOHN H. McGEHEE-TRACTS 5112E & 5101E

PLAN AND SECTIONS

MILE 641.0

ORDXE JULY 77



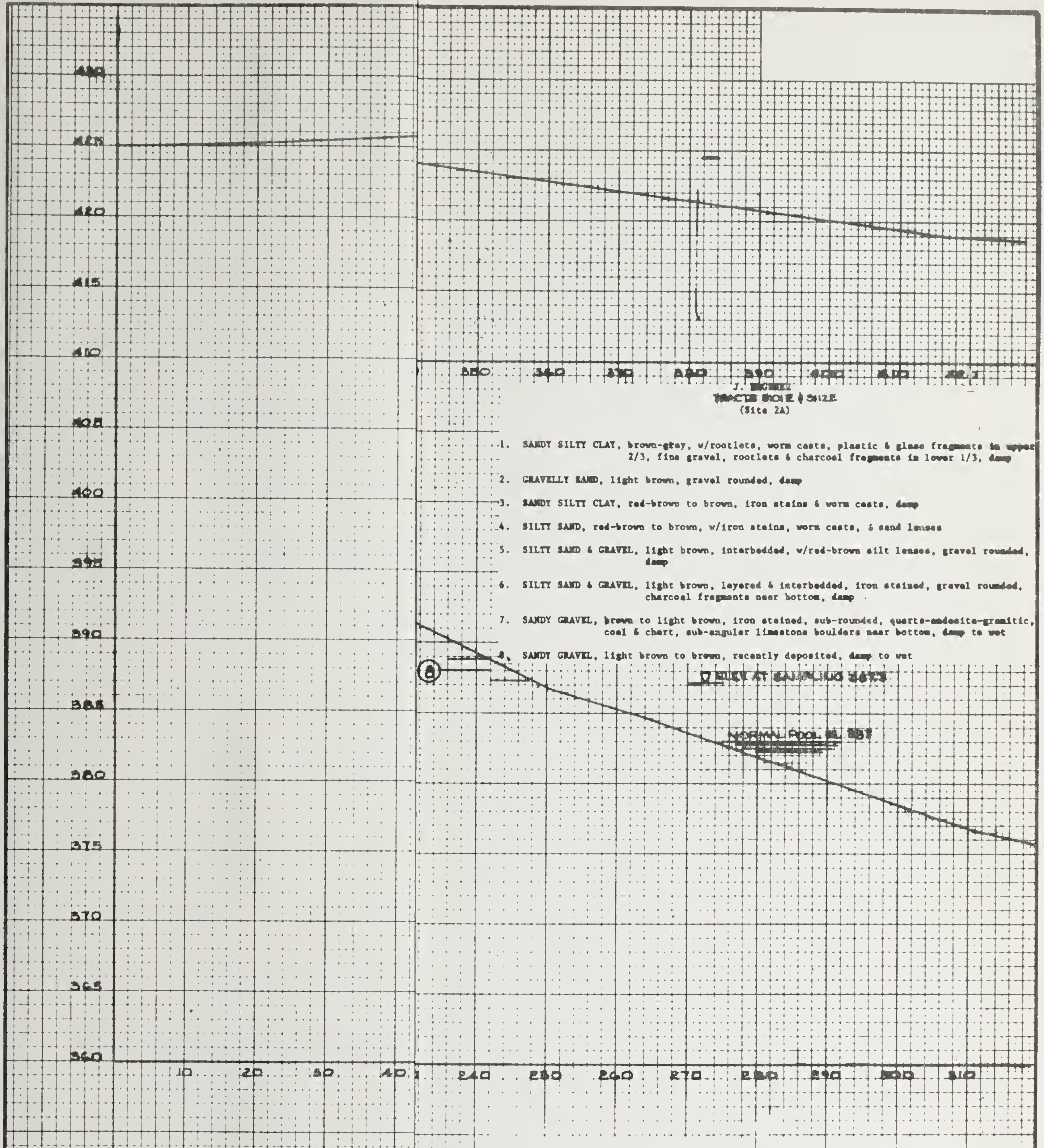


U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY

CANNELTON POOL

JOHN H. McGEHEE-TRACTS 5112E & 5101E
PLAN AND SECTIONS
MILE 641.0

ORDXE JULY 77



U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

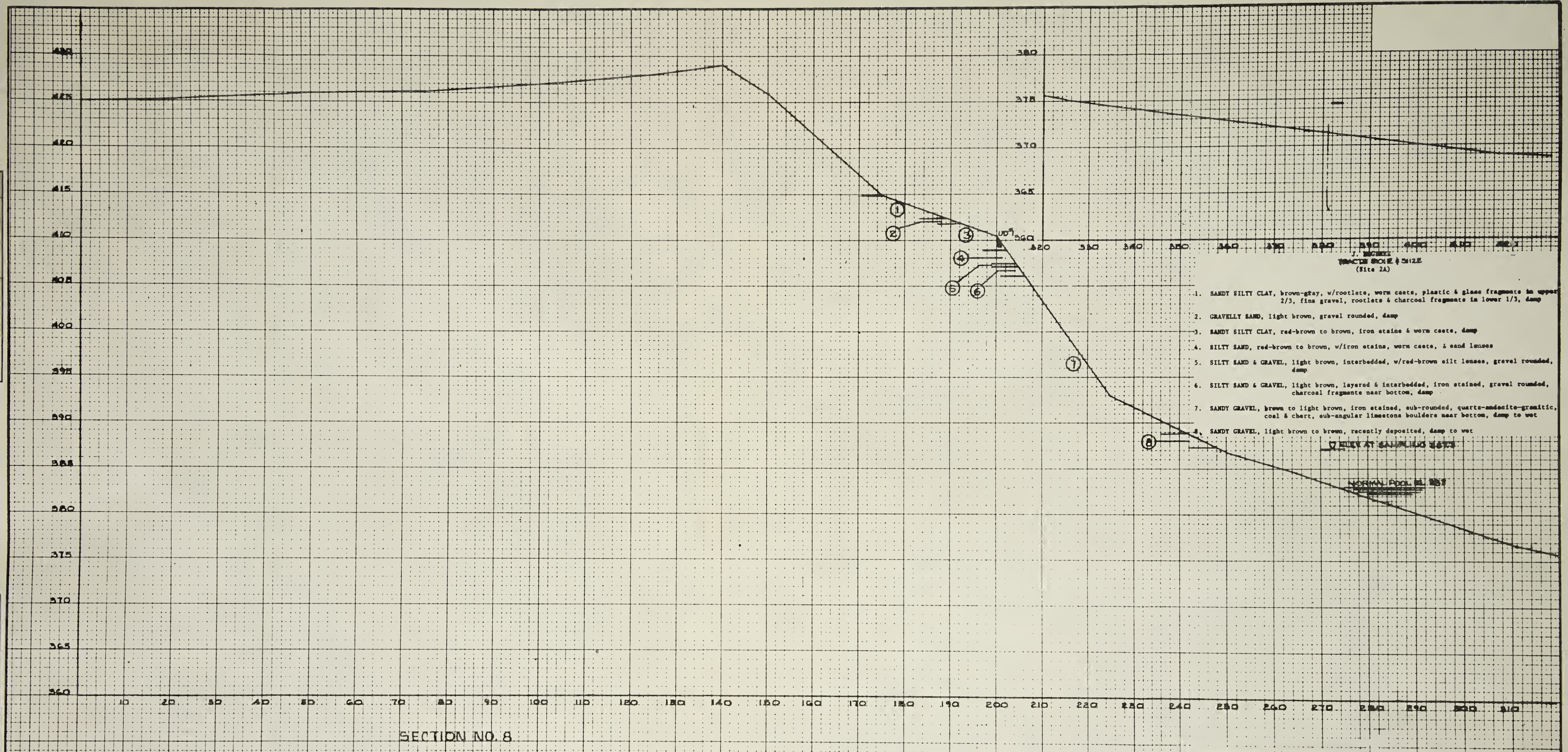
CANNELTON POOL

JOHN H. McGEHEE-TRACTS 5112E & 5101E

SOIL PROFILE

MILE 641.0

ORDXE JULY 77



U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY

CANNELTON POOL

JOHN H. McGEHEE-TRACTS 5112E & 5101E
SOIL PROFILE
MILE 641.0

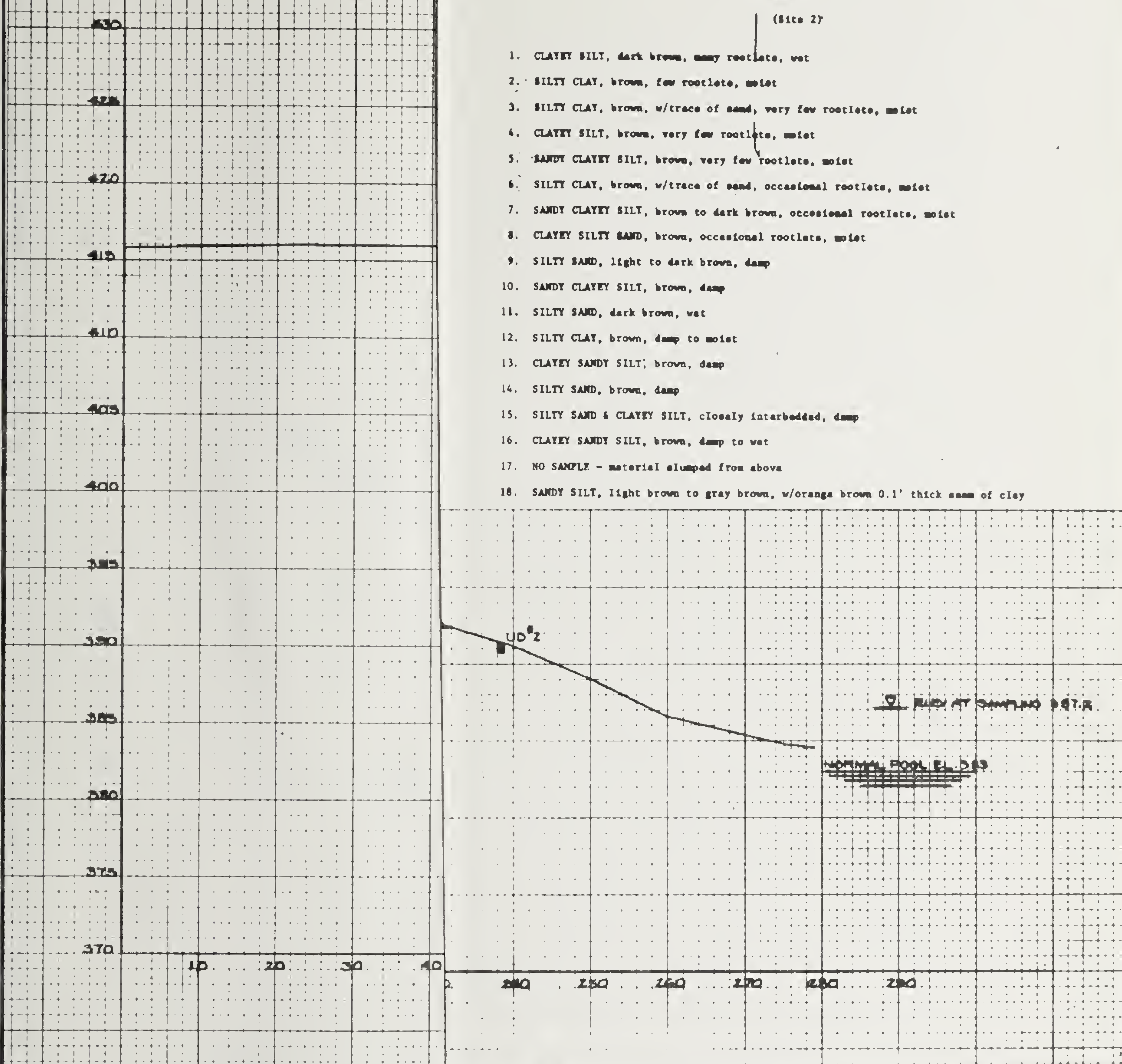
ORDXE JULY 77

J. McGEHEE

Tract 5101 E & 5112 E

(Site 2)

1. CLAYEY SILT, dark brown, many rootlets, wet
2. SILTY CLAY, brown, few rootlets, moist
3. SILTY CLAY, brown, w/trace of sand, very few rootlets, moist
4. CLAYEY SILT, brown, very few rootlets, moist
5. SANDY CLAYEY SILT, brown, very few rootlets, moist
6. SILTY CLAY, brown, w/trace of sand, occasional rootlets, moist
7. SANDY CLAYEY SILT, brown to dark brown, occasional rootlets, moist
8. CLAYEY SILTY SAND, brown, occasional rootlets, moist
9. SILTY SAND, light to dark brown, damp
10. SANDY CLAYEY SILT, brown, damp
11. SILTY SAND, dark brown, wet
12. SILTY CLAY, brown, damp to moist
13. CLAYEY SANDY SILT, brown, damp
14. SILTY SAND, brown, damp
15. SILTY SAND & CLAYEY SILT, closely interbedded, damp
16. CLAYEY SANDY SILT, brown, damp to wet
17. NO SAMPLE - material slumped from above
18. SANDY SILT, light brown to gray brown, w/orange brown 0.1' thick seam of clay



U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

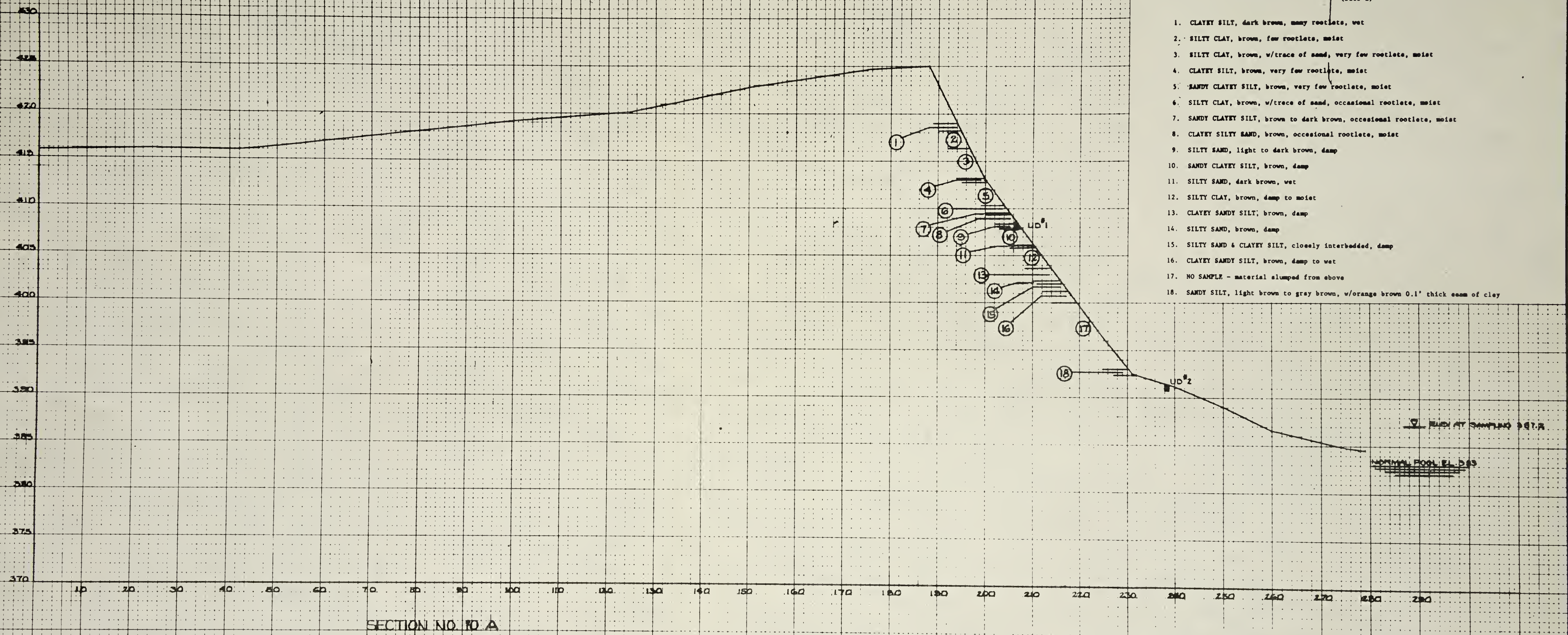
CANNELTON POOL

JOHN H. McGEHEE-TRACTS 5112E & 5101E

SOIL PROFILE

MILE 641.0

ORDXE JULY 77



J. McGEHEE

Tract 5101 E & 5112 E

(Site 2)

1. CLAYEY SILT, dark brown, many rootlets, wet
2. SILTY CLAY, brown, few rootlets, moist
3. SILTY CLAY, brown, w/trace of sand, very few rootlets, moist
4. CLAYEY SILT, brown, very few rootlets, moist
5. SANDY CLAYEY SILT, brown, very few rootlets, moist
6. SILTY CLAY, brown, w/trace of sand, occasional rootlets, moist
7. SANDY CLAYEY SILT, brown to dark brown, occasional rootlets, moist
8. CLAYEY SILTY SAND, brown, occasional rootlets, moist
9. SILTY SAND, light to dark brown, damp
10. SANDY CLAYEY SILT, brown, damp
11. SILTY SAND, dark brown, wet
12. SILTY CLAY, brown, damp to moist
13. CLAYEY SANDY SILT, brown, damp
14. SILTY SAND, brown, damp
15. SILTY SAND & CLAYEY SILT, closely interbedded, damp
16. CLAYEY SANDY SILT, brown, damp to wet
17. NO SAMPLE - material slumped from above
18. SANDY SILT, light brown to gray brown, w/orange brown 0.1' thick seam of clay

FINAL SURVEY	BY	DATE
SURVEYED		
PLOTTED		
TEMPLATE		
NOTE BOOK		
AREAS		
NO.		
AREAS CHECKED		

ORIGINAL SURVEY	BY	DATE
SURVEYED		
PLOTTED		
TEMPLATE		
NOTE BOOK		
AREAS		
NO.		
AREAS CHECKED		

U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

CANNELTON POOL

JOHN H. McGEHEE-TRACTS 5112E & 5101E

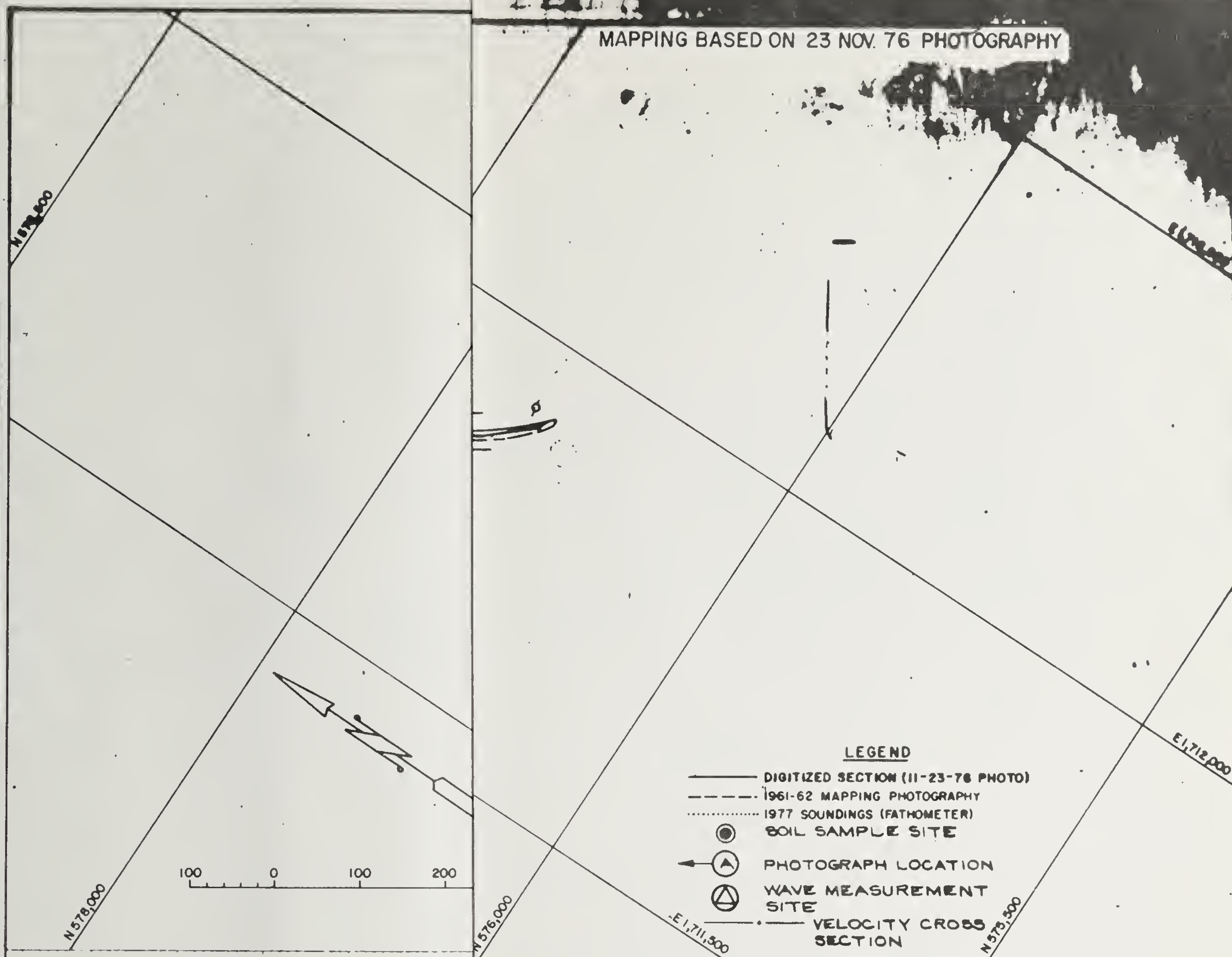
SOIL PROFILE

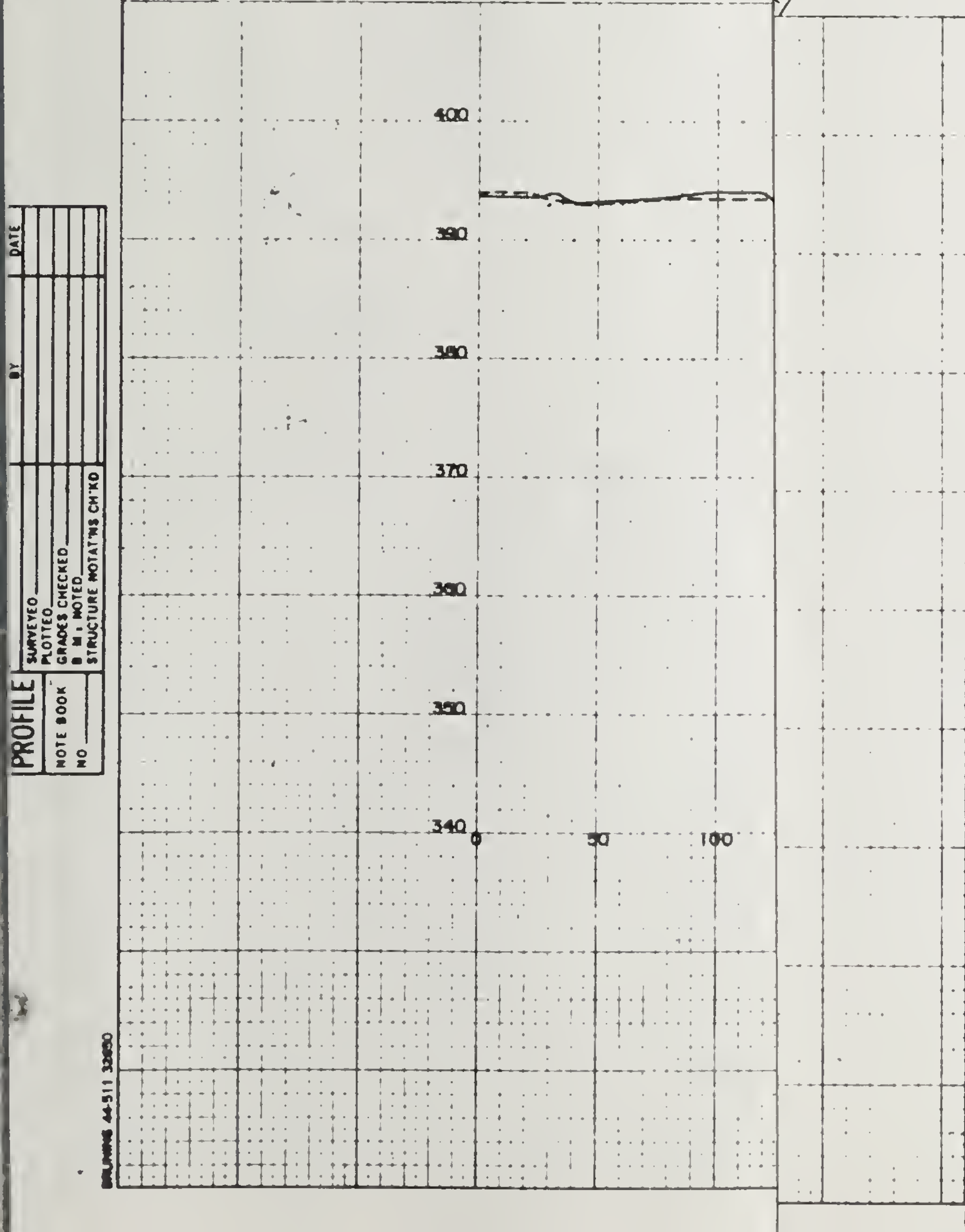
MILE 641.0

ORDXE

JULY 77

MAPPING BASED ON 23 NOV. 76 PHOTOGRAPHY





U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

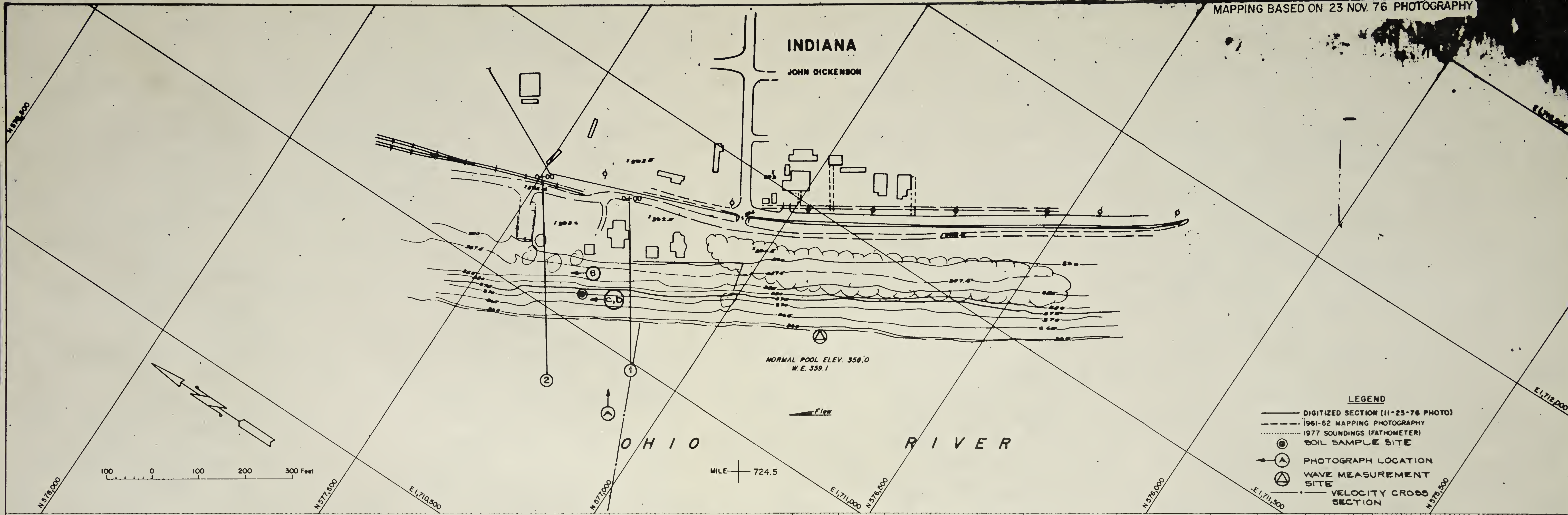
NEWBURGH POOL

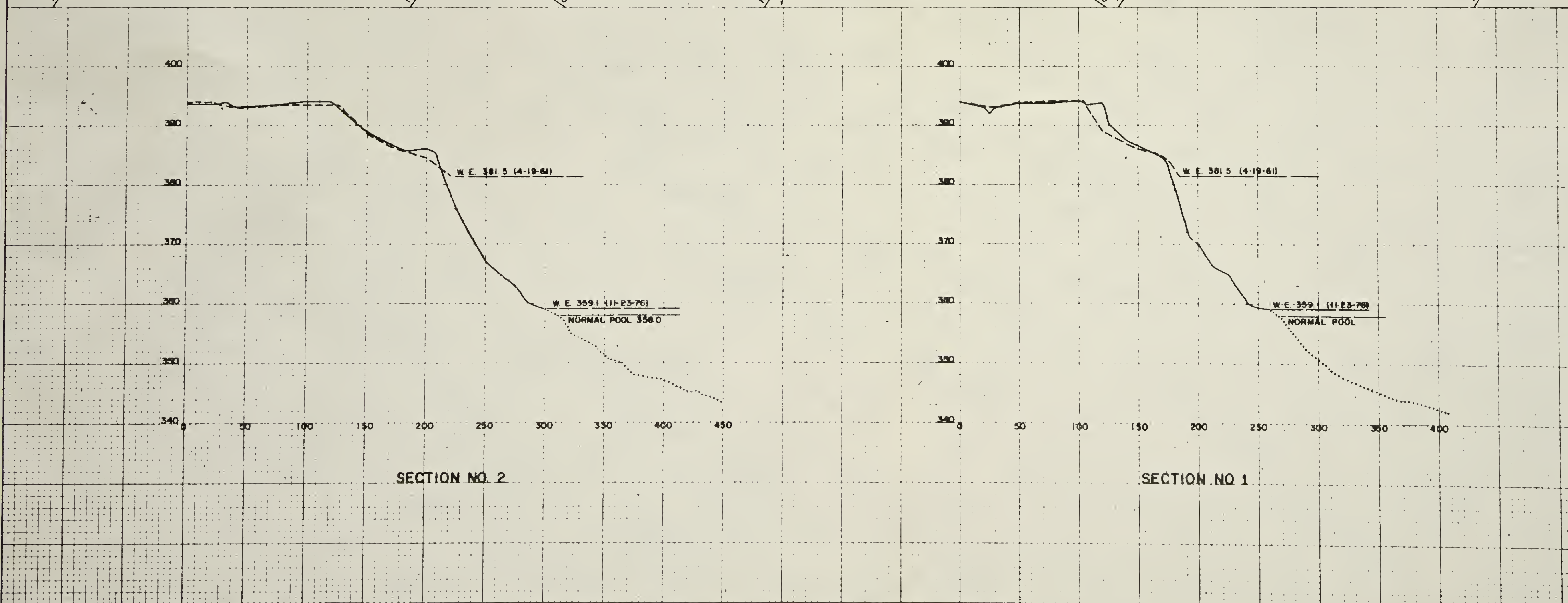
JOHN DICKENSON

PLAN AND SECTIONS

MILE 721.3

ORDXE JULY 77





U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY

NEWBURGH POOL

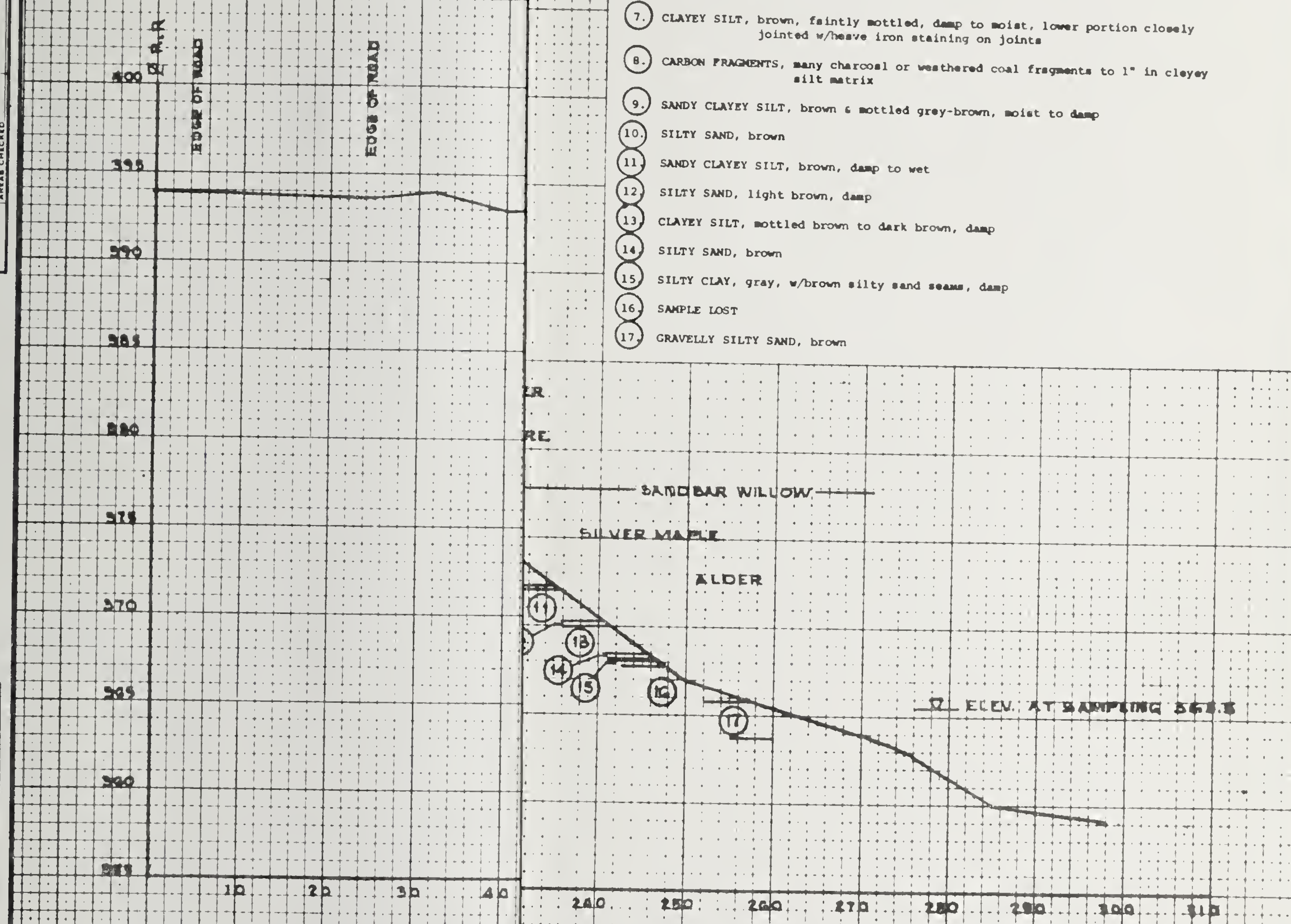
JOHN DICKENSON
PLAN AND SECTIONS
MILE 721.3

ORDXE JULY 77

PLATE 50

DICKENSON

1. SANDY CLAYEY SILT, dark brown, rootlets, trace of organics, moist
2. SANDY CLAYEY SILT, brown, few rootlets, moist, thinly scattered charcoal lumps
3. CLAYEY SANDY SILT, brown, interbedded sandy & silty seams, numerous charcoal frags
4. SANDY CLAYEY SILT, brown, w/few irregular seams & lenses of silt and silty sand, few scattered charcoal lumps, few rootlets
5. SANDY CLAYEY SILT, brown, some mottled iron staining, moist no charcoal
6. CARBON FRAGMENTS, many charcoal or weathered coal fragments to 1/2" in clayey silt matrix
7. CLAYEY SILT, brown, faintly mottled, damp to moist, lower portion closely jointed w/heave iron staining on joints
8. CARBON FRAGMENTS, many charcoal or weathered coal fragments to 1" in clayey silt matrix
9. SANDY CLAYEY SILT, brown & mottled grey-brown, moist to damp
10. SILTY SAND, brown
11. SANDY CLAYEY SILT, brown, damp to wet
12. SILTY SAND, light brown, damp
13. CLAYEY SILT, mottled brown to dark brown, damp
14. SILTY SAND, brown
15. SILTY CLAY, gray, w/brown silty sand seams, damp
16. SAMPLE LOST
17. GRAVELLY SILTY SAND, brown



U.S. ARMY CORPS OF ENGINEERS

OHIO RIVER DIVISION

BANK EROSION STUDY

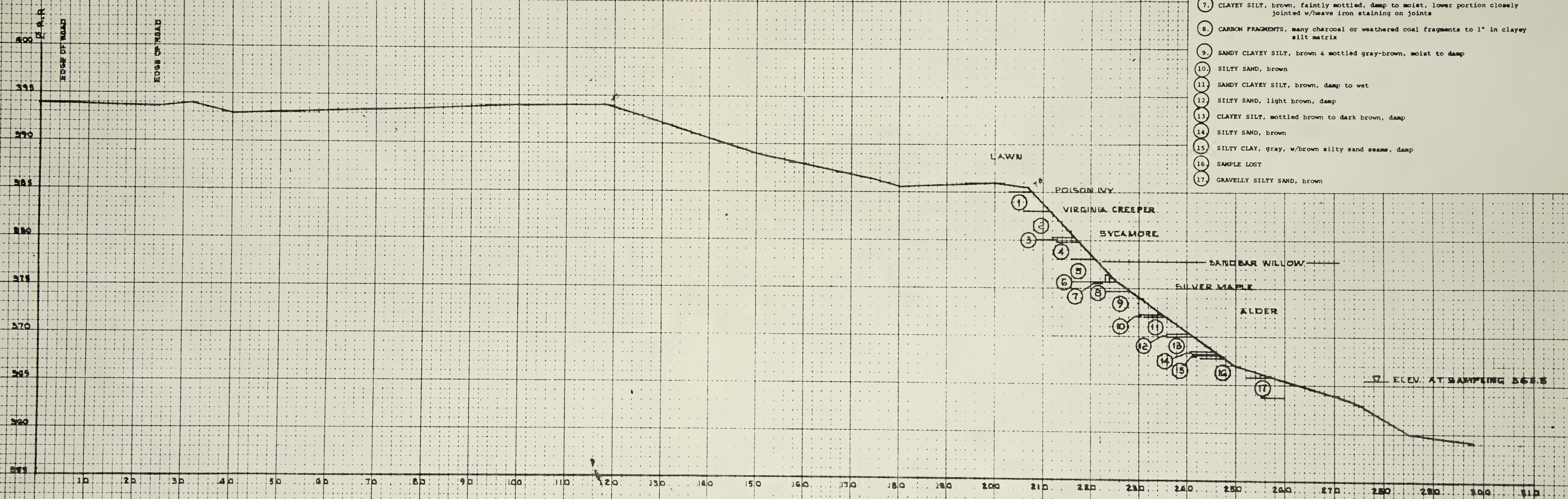
NEWBURGH POOL

JOHN DICKENSON

SOIL & VEGETATION PROFILE

MILE 721.3

ORDXE JULY 77



SECTION NO. 2

DICKENSON

1. SANDY CLAYEY SILT, dark brown, rootlets, trace of organics, moist
2. SANDY CLAYEY SILT, brown, few rootlets, moist, thinly scattered charcoal lumps
3. CLAYEY SANDY SILT, brown, interbedded sandy & silty seams, numerous charcoal frags
4. SANDY CLAYEY SILT, brown, w/few irregular seams & lenses of silt and silty sand, few scattered charcoal lumps, few rootlets
5. SANDY CLAYEY SILT, brown, some mottled iron staining, moist no charcoal
6. CARBON FRAGMENTS, many charcoal or weathered coal fragments to 1/2" in clayey silt matrix
7. CLAYEY SILT, brown, faintly mottled, damp to moist, lower portion closely jointed w/heave iron staining on joints
8. CARBON FRAGMENTS, many charcoal or weathered coal fragments to 1" in clayey silt matrix
9. SANDY CLAYEY SILT, brown & mottled gray-brown, moist to damp
10. SILTY SAND, brown
11. SANDY CLAYEY SILT, brown, damp to wet
12. SILTY SAND, light brown, damp
13. CLAYEY SILT, mottled brown to dark brown, damp
14. SILTY SAND, brown
15. SILTY CLAY, gray, w/brown silty sand seams, damp
16. SAMPLE LOST
17. GRAVELLY SILTY SAND, brown

U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY

NEWBURGH POOL

JOHN DICKENSON
SOIL & VEGETATION PROFILE
MILE 721.3

ORDXE JULY 77

APPENDIX A

SITE DESCRIPTIONS

TABLE OF CONTENTS

PLATES

APPENDIX A

SITE DESCRIPTIONS

1. Introduction. The purposes of this appendix is to give a brief description of the litigation sites for purpose of identification. These descriptions are not legal property descriptions. The real estate acquisition maps available in the Louisville and Huntington Districts were used as a basis for the descriptions; acreages listed are those of the entire property. The general locations of the sites in the Meldahl, Cannelton, and Newburgh pool areas are shown on Plates A-1 and A-2. Detailed map of each site is presented on Plates A-3 through A-24.

2. Site Descriptions - Meldahl Pool.

a. Ethyl Rice - Tract 523E - The property shown on Plate A-3 is located on the right descending bank of the Ohio River, in the vicinity of Ohio River Mile 429.0, the approximate upstream and downstream boundaries being at River Miles 429.1 and 429.3. The area is relatively flat; the downstream boundary is at a small creek. The approximate acreage is 55 acres.

b. Eugene & Elizabeth Poston - Tracts 527E - 1 & 2 - The property shown on Plate A-4 is located on the right descending bank of the Ohio River, in the vicinity of Ohio River Mile 429.0, the approximate upstream and downstream limits being at River Miles 428.8 and 429.1. A small unnamed creek traverses the property; the terrain is relatively flat. The approximate acreage is 85 acres.

c. Charles & Jean Rice - Tracts 533E - 1 & 2 - The property shown on Plate A-5 is located on the right descending bank of the Ohio River, in the vicinity of Ohio River Mile 428.0, the approximate upstream and downstream boundaries being at River Miles 428.3 and 428.4. The terrain varies from flat to gently rolling; the total acreage is approximately 35 acres.

d. Norman & Anna Wood - Tract 1209E - The property shown on Plate A-6 is located on the right descending bank of the Ohio River, in the vicinity of Ohio River Mile 412.7, the approximate upstream and downstream boundaries being at River Miles 412.7 and 412.9. The terrain rises steeply at the rear of the property which is bounded by U.S. Rt. 52. The approximate acreage is 16 acres.

e. Donald & Mary McNelly - Tract 1301E - The property shown on Plate A-7 is located on the right descending bank of the Ohio River, in the vicinity of Ohio River Mile 412.5, the approximate upstream and downstream boundaries being at River Miles 412.2 and 412.6. The portion adjacent to the river is relatively flat, rising towards the rear of the property. The approximate acreage is 65 acres.

f. James & Cheryl Chouinard - Tract 1305E - The property shown on Plate A-8 is located on the right descending bank of the Ohio River in the vicinity of River Mile 412.1, with a river frontage of approximately 800 feet. The upstream boundary is formed by Three-Mile Creek, a tributary of the Ohio. The approximate four acres is used for a homesite and contains a residence.

g. Jacob & Josephine Schwab - Tract 1307E - The property shown on Plate A-9 is located on the right descending bank of the Ohio River in the vicinity of River Mile 412.0. The area is located between Three-Mile Creek, a tributary of the Ohio River, and has an approximate acreage of 28 acres. The terrain is flat, except for the vicinity of the creek. Approximate upstream and downstream boundaries are at River Miles 412.0 and 411.8.

h. Bernard Griffith - Tracts 1353E - 1 & 2 - The property shown on Plate A-10 is located on the right descending bank of the Ohio River near River Mile 411.3. The upstream and downstream boundaries are approximately at River Miles 411.2 and 411.5. The property is located between the Three-Mile Creek and the Ohio River and consisting of a flat flood plain of approximately 40 acres.

i. Beauford Cunningham - Tract 2102E - 1 & 2 - The property shown on Plate A-11 is located on the left descending bank of the Ohio River in the vicinity of River Mile 394.5, with the approximate upstream and downstream boundaries being between River Miles 394.3 and 394.7. A small creek crosses the property; the approximate acreage is 210 acres. The terrain varies from flat to gently rolling.

3. Site Descriptions - Cannelton Pool.

a. George Wagner - Tract 410E - This property as shown on Plate A-12 is located at the right descending bank of the Ohio River at approximately Ohio River Mile 718.3. The river frontage is approximately 100 feet; the property extends approximately 300 feet in depth to Indiana State Route 166. The property is sloping steeply from the riverbank to the inland boundary along the State Route. Total acreage is approximately 0.67 acre.

b. Henriella Bynon - Tract 640E - The property as shown on Plate A-13 is located on the right descending bank of the Ohio River at Ohio River Mile 717.9 having an approximate frontage of 65 feet. The back of the property slopes toward and abuts Indiana State Route 166. Approximate acreage is 0.50 acre.

c. Douglas Leatherbury - Tract 719E - The property as shown on Plate A-14 is located on the right descending bank of the Ohio River in the vicinity of Ohio River Mile 714.4, with the approximate upstream and downstream boundaries at River Miles 714.2 and 714.5. A small tributary

(Pond River) bisects the area near the downstream end of the property. The topography is relatively flat except in the vicinity of the tributary. Total acreage is approximately 70 acres.

d. Earl Loesch et ux - Tracts 1300E - 1 & 2. 1318E - The property as shown on Plate A-15 is located on the right descending bank of the Ohio River in the vicinity of Ohio River Mile 708.3, with the approximate upstream and downstream limits at River Miles 708.3 and 708.6. Most of the area is flat, the total approximate acreage being 192 acres. A portion of the tract is adjacent to a small tributary.

e. Chester Eaton & Gerald Williams - Tract 2200E - The property as shown on Plate A-16 is located at the right descending bank of the Ohio River in the vicinity of Ohio River Mile 696.4, the approximate upstream and downstream boundaries are at River Miles 696.3 and 696.5. Most of the total acreage of 61 acres is along the Big Poison Creek, a tributary of the river, leaving only a small strip of land as river frontage. This landward boundary of this part of the property is formed by the Little Poison Creek, another tributary. Most of the topography is relatively flat.

f. Billy Glenn - Tracts 2215E, 2218E, 2410E - This property as shown on Plates A-17 and Plate A-17/1 fronts on the right descending bank of the Ohio River at three locations in the vicinity of River Miles 693 and 694. One locations is between River Miles 692.5 and 693.4, another is between River Miles 693.6 and 694.1, and the third locations has an approximate frontage of 200 feet at River Mile 694.2. The total combined acreage is 318 acres; the topography varies from flat to gently rolling. The area is traversed by several small unnamed streams.

g. Clyde & Mary Benner et ux - Tract 3015E - This property as shown on Plate A-18 occupies a relatively narrow strip of land on the right descending bank of the Ohio River with approximate upstream and downstream boundaries at River Miles 683.3 and 684.0. The property is located between the river and Indiana State Highway No. 66, the total acreage being approximately 80 acres. The terrain is relatively flat.

h. Nicholas Purcell et ux - Tracts 3229E & 3238E - The property as shown on Plate A-19 is located on both banks of Mill Creek, a tributary of the Little Blue River, which empties in the Ohio River at River Mile 678.5. The tract consists of two areas - a five-acre homesite and a farm of approximately 30 acres. The homesite is at the top of a relatively steep riverbank.

i. Ralph Cox et ux - Tract 3703E - The property as shown on Plate A-20 is located on the right descending bank of the Ohio River, in the vicinity of Ohio River Mile 670.0, with the approximate upstream and downstream boundaries being River Miles 669.8 and 670.2. The total acreage is 99 acres, and the terrain varies from flat to gently rolling.

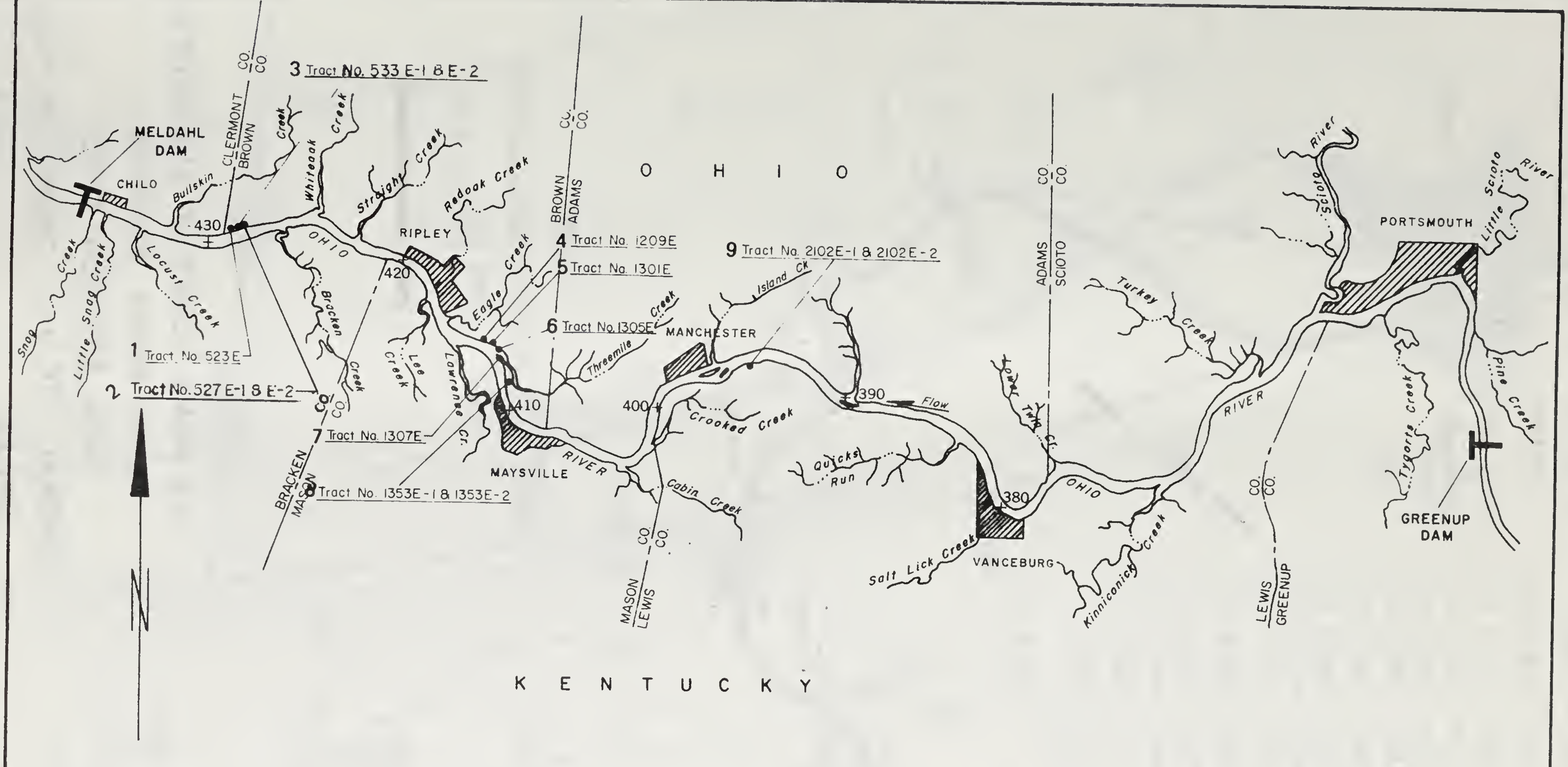
j. John H. McGehee et ux - Tract 3828E - The property as shown on Plate A-21 is located on the left descending bank of the Ohio River, in the vicinity of Ohio River Mile 668.5, with the upstream and downstream boundaries being at approximately River Miles 668.3 and 668.6. The terrain in the vicinity of the river is fairly flat, with the total acreage being approximately 216 acres.

k. E. Davis McGehee et ux - Tract 5018E - The property as shown on Plate A-22 is located at approximately Ohio River Mile 640.0 on the left descending bank of the Ohio River, the upstream and downstream boundaries are approximately at River Miles 639.4 and 640.4. A tributary, Doe Run Creek, joins the Ohio River at the downstream boundary; the property is traversed by the L & N Railroad Company. The total acreage is approximately 398 acres. The topography varies from flat in the vicinity of the river to gently rolling in the back.

l. John H. McGehee et ux - Tracts 5101E and 5112E - The property as shown on Plates A-23 and A-23/1 is located in the vicinity of Ohio River Mile 641.0 on the left descending bank of the Ohio River, with the upstream and downstream boundaries being at approximately River Miles 640.4 and 641.1. The total acreage is 333 acres; the terrain varies from flat to gently rolling.

4. Site Description - Newburgh Pool.

a. John Dickenson Site - The property as shown on Plate A-24 is located on the right descending bank of the Ohio River approximately at River Mile 724.6. It has a frontage of approximately 100 feet and extends towards the floodwall protecting the City of Cannelton. The property is a homesite; the acreage is approximately 0.70 acre.



NUMBER	NAME	TRACT	MILE
1	Rice, E.	523E	429.1
2	Poston	527E1&E2	428.9
3	Rice, C.& J.	533E1&E2	428.3
4	Wood	1209E	412.8
5	McNelly	1301E	412.6
6	Chouimard	1305E	412.1
7	Schwab	1307E	411.9
8	Griffith	1353E1&E2	411.3
9	Cunningham	2102E1&E2	394.5

LEGEND

Normal Pool Meldahl Dam Elev. 485

+400 RIVER MILE

SCALE IN MILES

4 0 8

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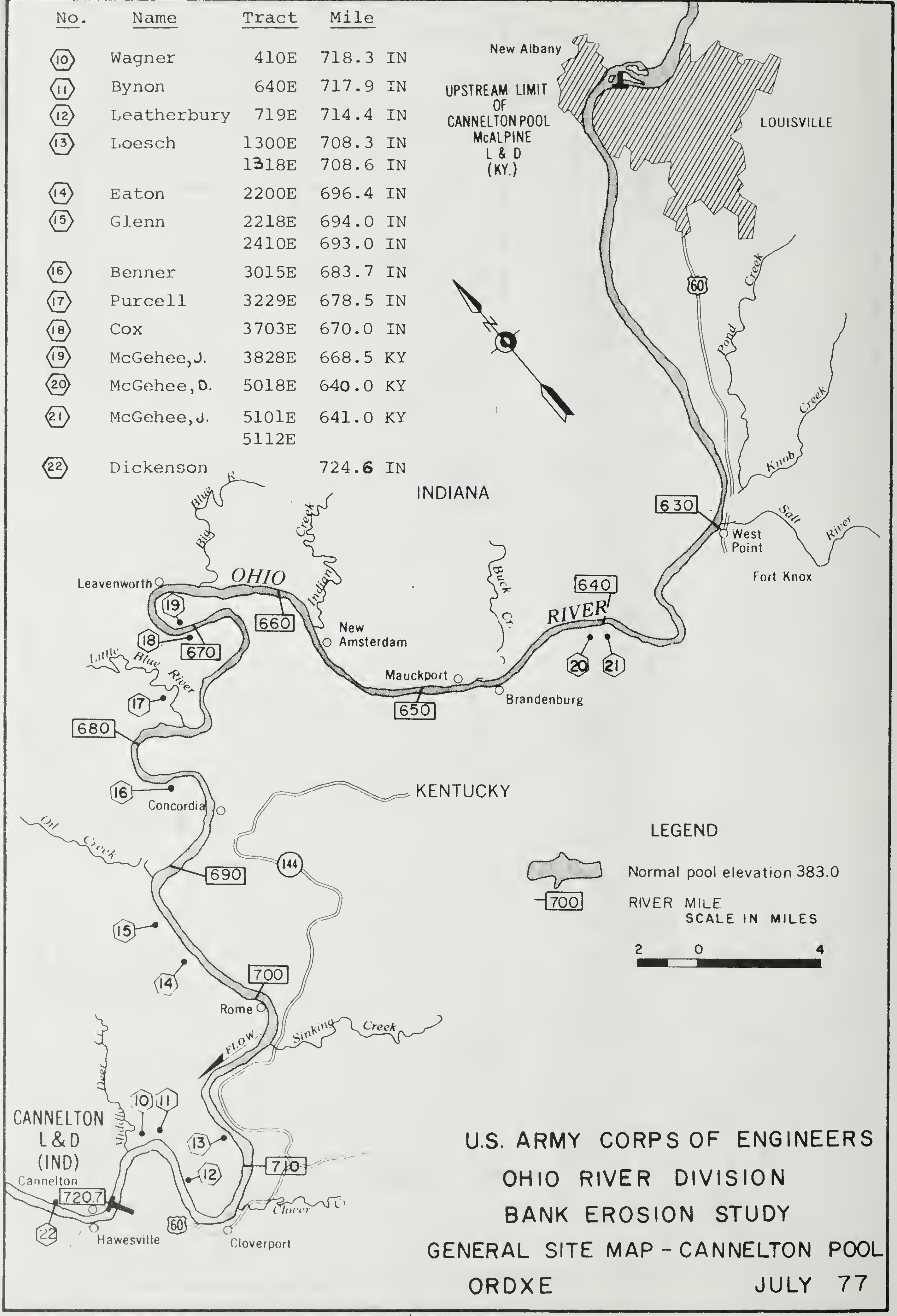
OHIO RIVER DIVISION
BANK EROSION STUDY

GENERAL SITE MAP - MELDAHL POOL

ORDXE

JULY 77

No.	Name	Tract	Mile
10	Wagner	410E	718.3 IN
11	Bynon	640E	717.9 IN
12	Leatherbury	719E	714.4 IN
13	Loesch	1300E	708.3 IN
		1318E	708.6 IN
14	Eaton	2200E	696.4 IN
15	Glenn	2218E	694.0 IN
		2410E	693.0 IN
16	Benner	3015E	683.7 IN
17	Purcell	3229E	678.5 IN
18	Cox	3703E	670.0 IN
19	McGehee, J.	3828E	668.5 KY
20	McGehee, D.	5018E	640.0 KY
21	McGehee, J.	5101E	641.0 KY
		5112E	
22	Dickenson		724.6 IN



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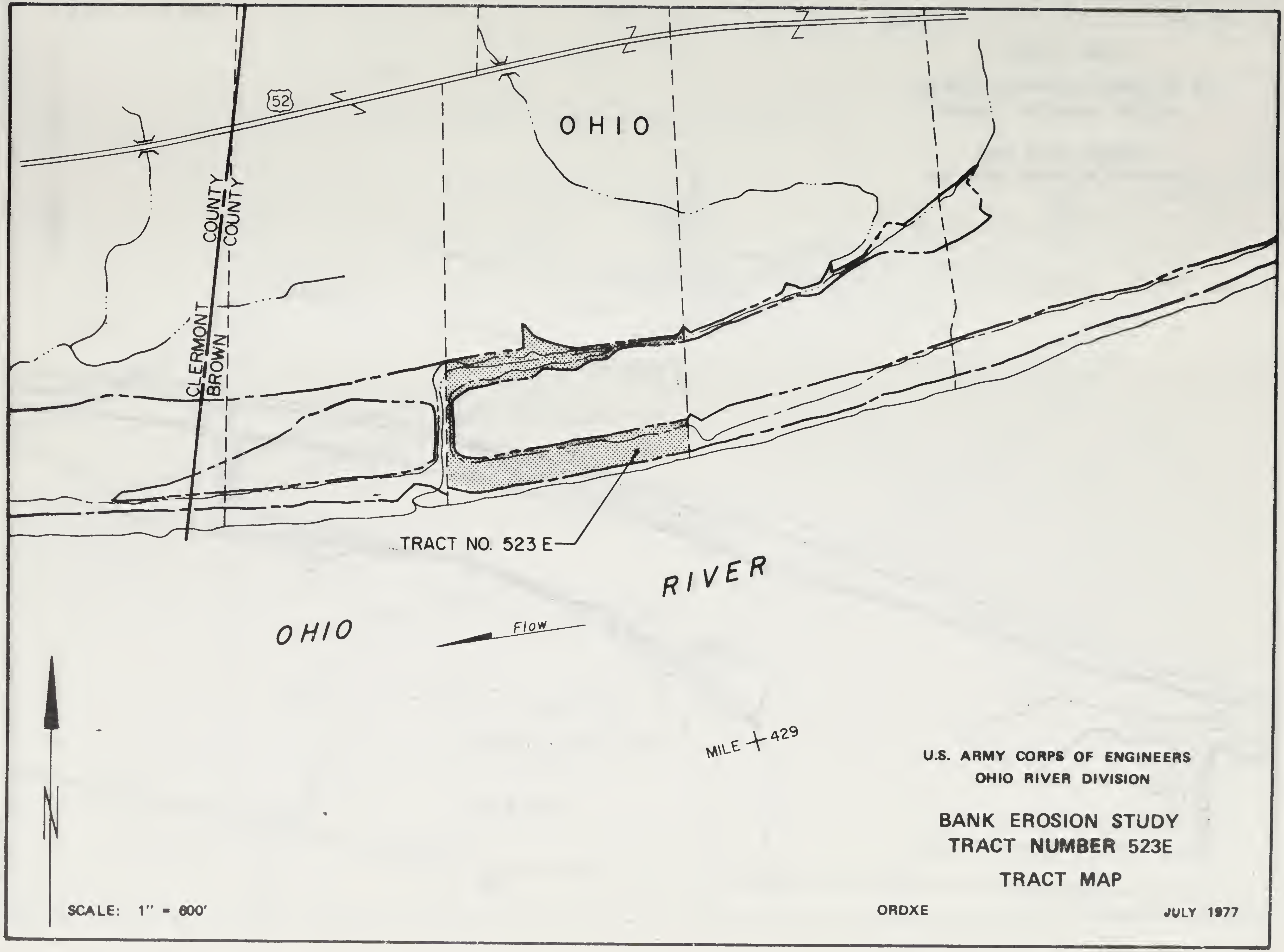
OHIO RIVER DIVISION
BANK EROSION STUDY
GENERAL SITE MAP - CANNELTON POOL
ORDXE JULY 77

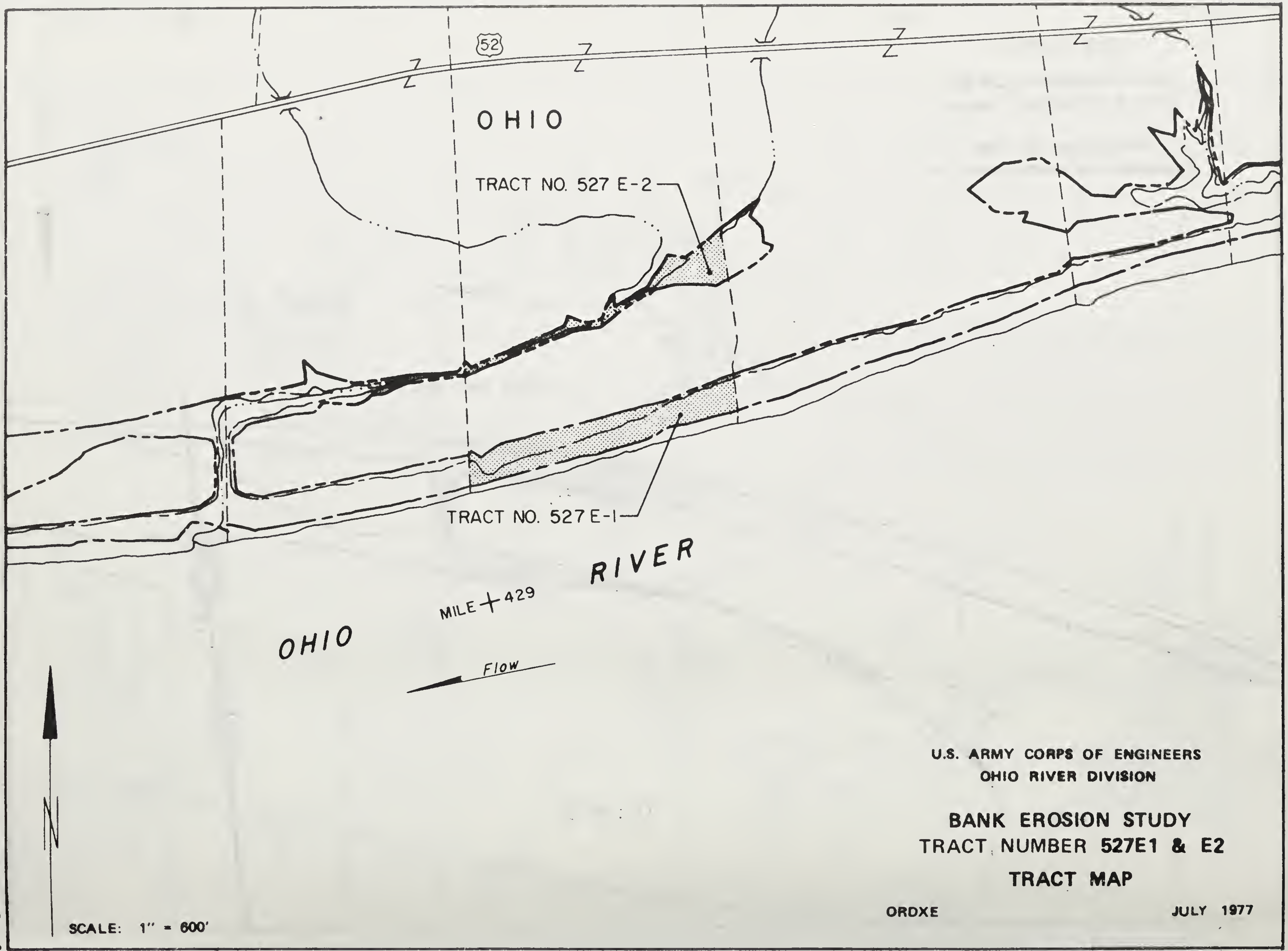
PLATE A-2



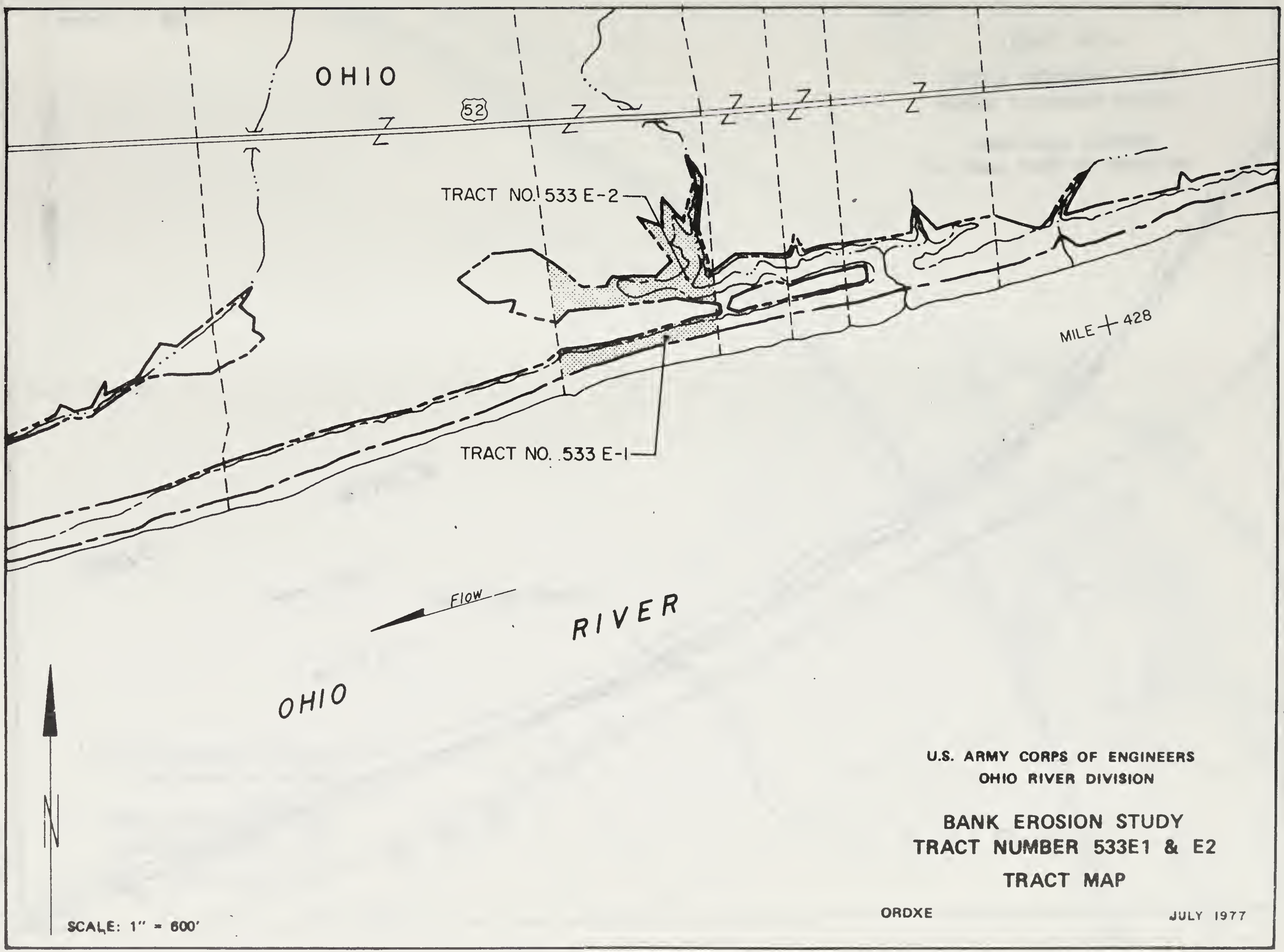
U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION

BANK EROSION STUDY
TRACT NUMBER 523E
TRACT MAP

PLATE A–3



52
OHIO
TRACT NO. 527 E-2
TRACT NO. 527 E-1
RIVER
MILE 429
OHIO
FLOW
N
SCALE: 1" = 600'
U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY
TRACT NUMBER 527E1 & E2
TRACT MAP
ORDXE
JULY 1977



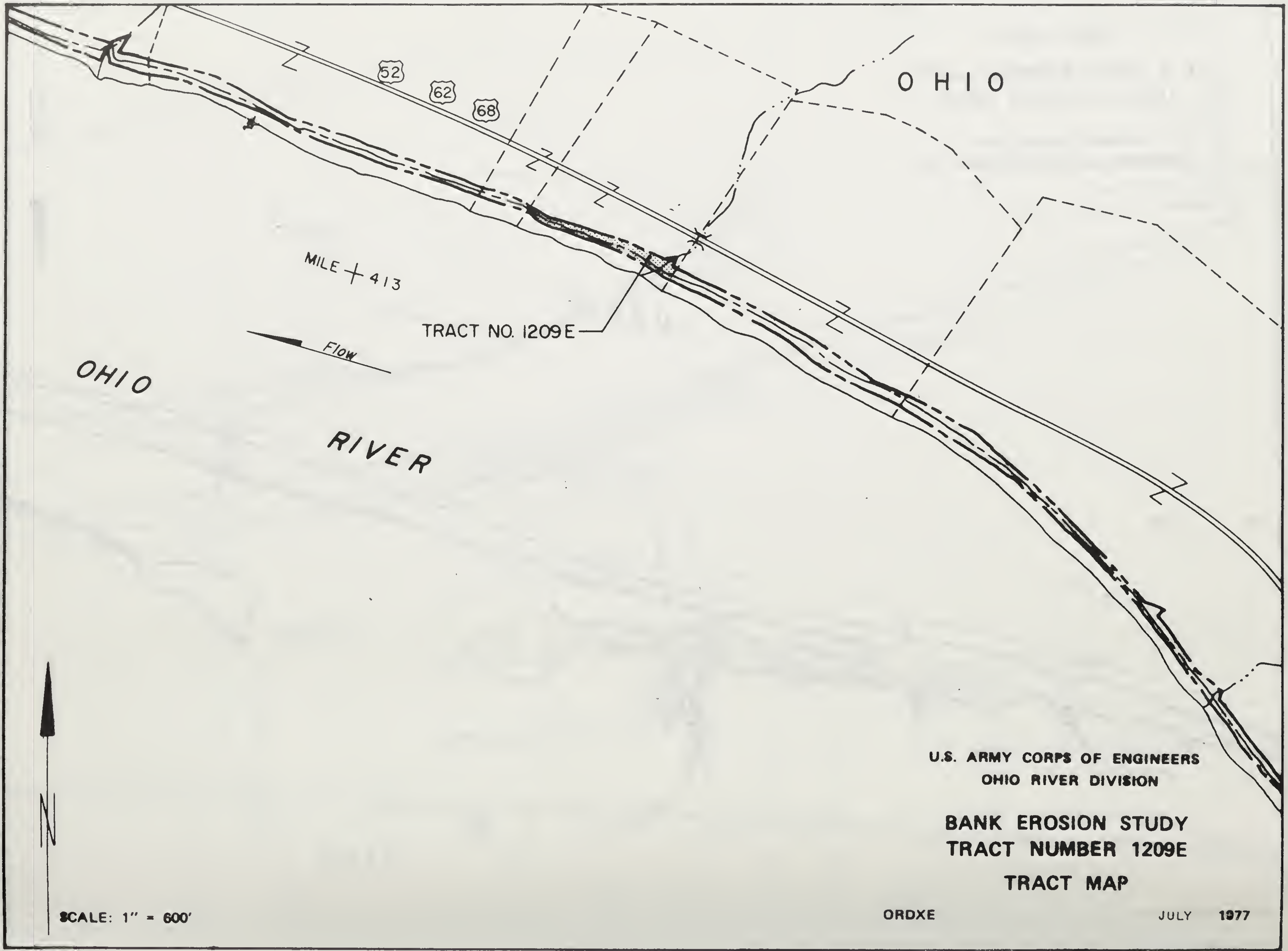
U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION

BANK EROSION STUDY
TRACT NUMBER 533E1 & E2
TRACT MAP

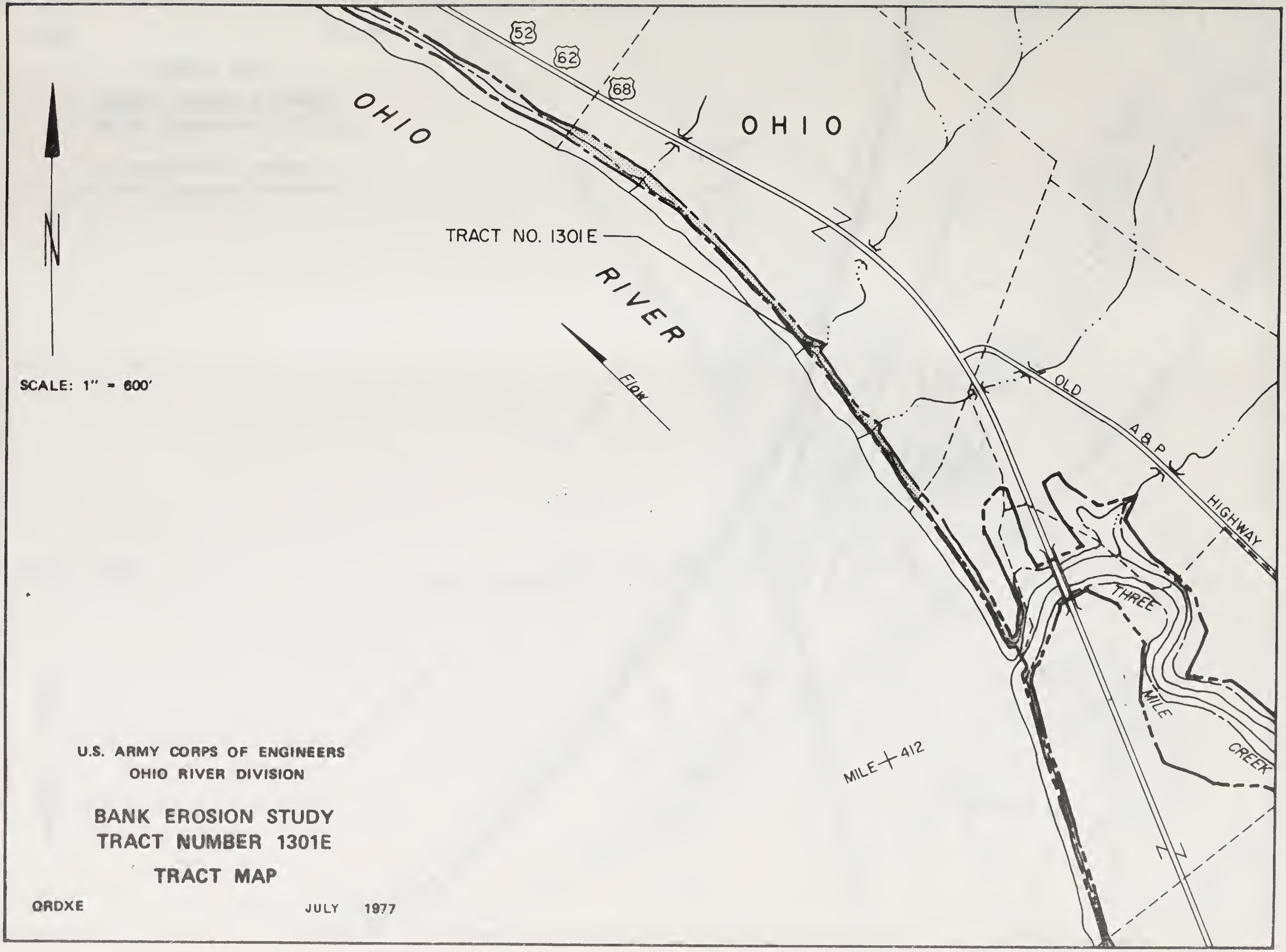
ORDXE

JULY 1977

PLATE A-5



OHIO
52
62
68
MILE 413
TRACT NO. 1209E
Flow
OHIO
RIVER
U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY
TRACT NUMBER 1209E
TRACT MAP
SCALE: 1" = 600'
ORDXE
JULY 1977

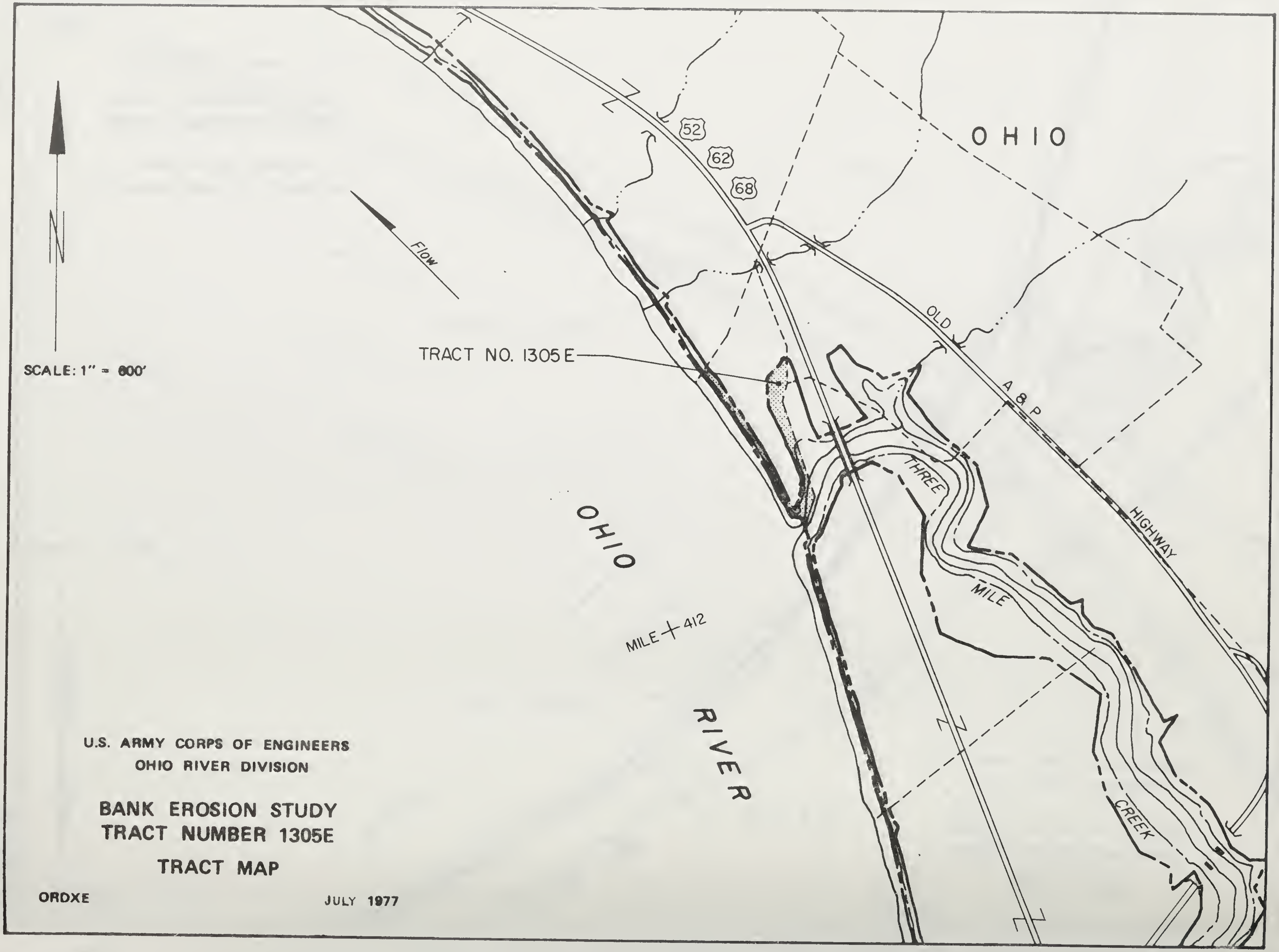


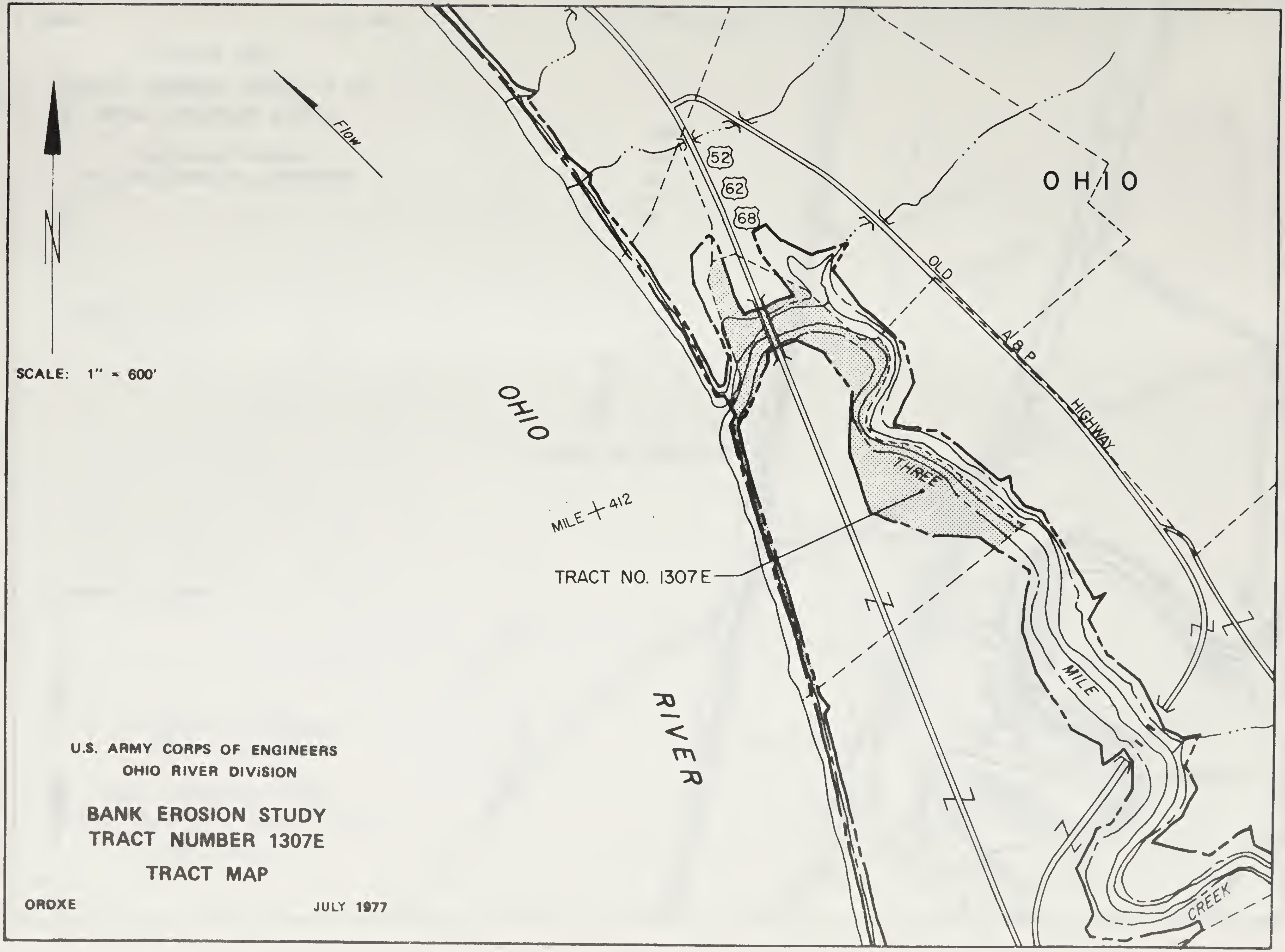
U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION

BANK EROSION STUDY
TRACT NUMBER 1301E
TRACT MAP

ORDXE JULY 1977

PLATE A–7


OHIO
52
62
68
OLD A & P HIGHWAY
THREE MILE CREEK
Flow
TRACT NO. 1305E
SCALE: 1" = 600'
OHIO RIVER
MILE 412
U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY
TRACT NUMBER 1305E
TRACT MAP
ORDXE
JULY 1977



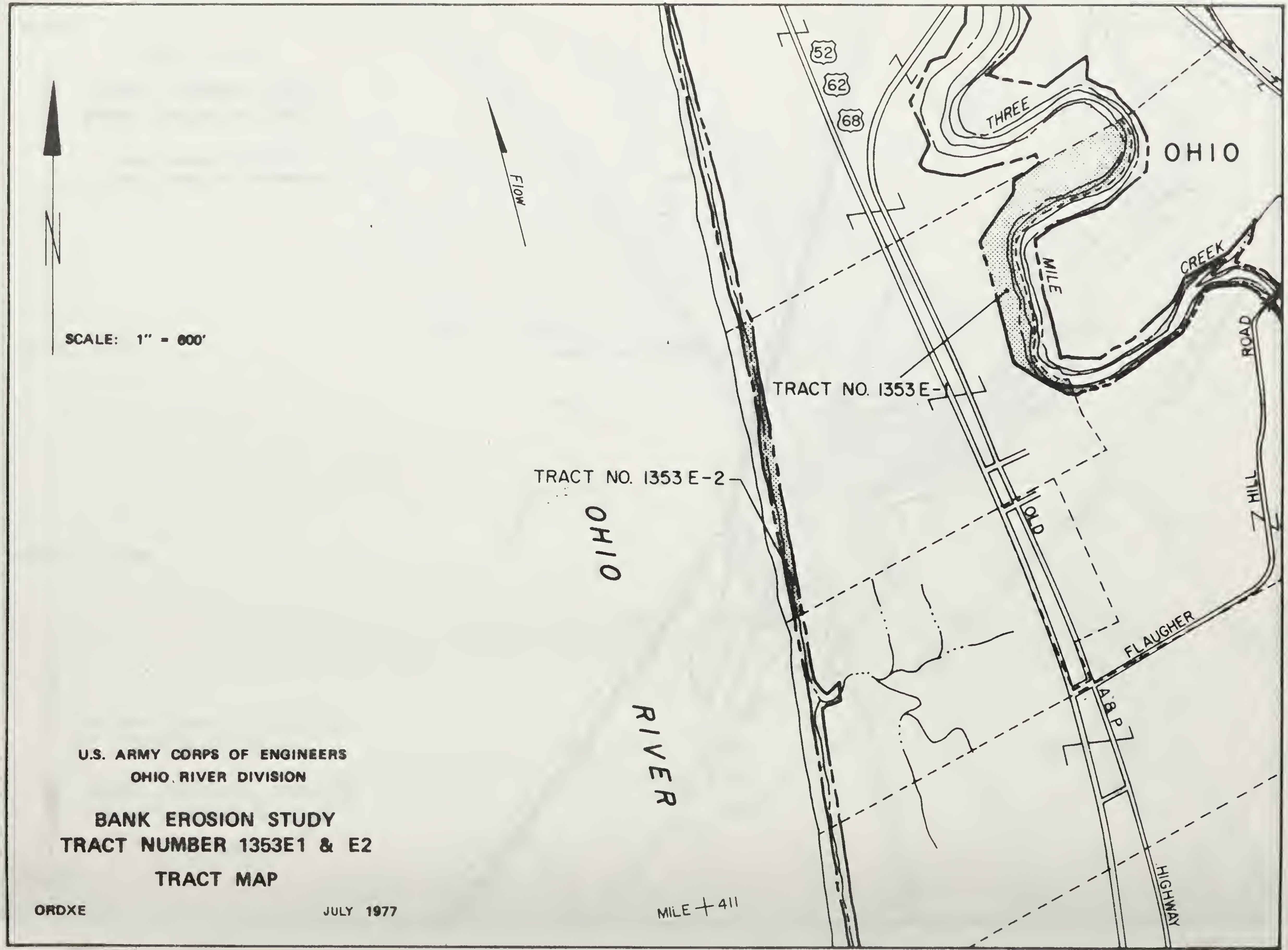
U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION

BANK EROSION STUDY
TRACT NUMBER 1307E
TRACT MAP

ORDXE

JULY 1977

PLATE A–9

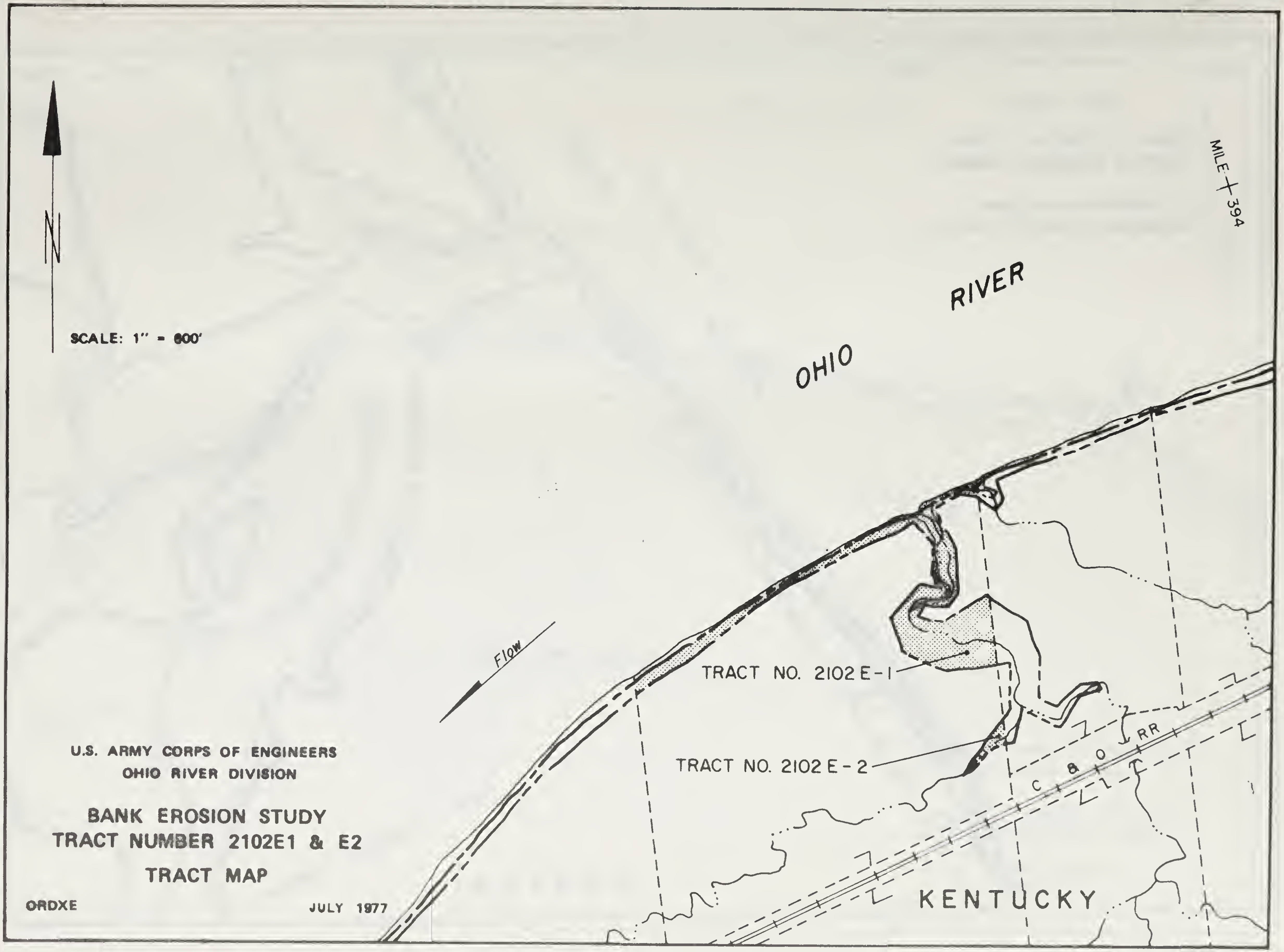


U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION

BANK EROSION STUDY
TRACT NUMBER 1353E1 & E2
TRACT MAP

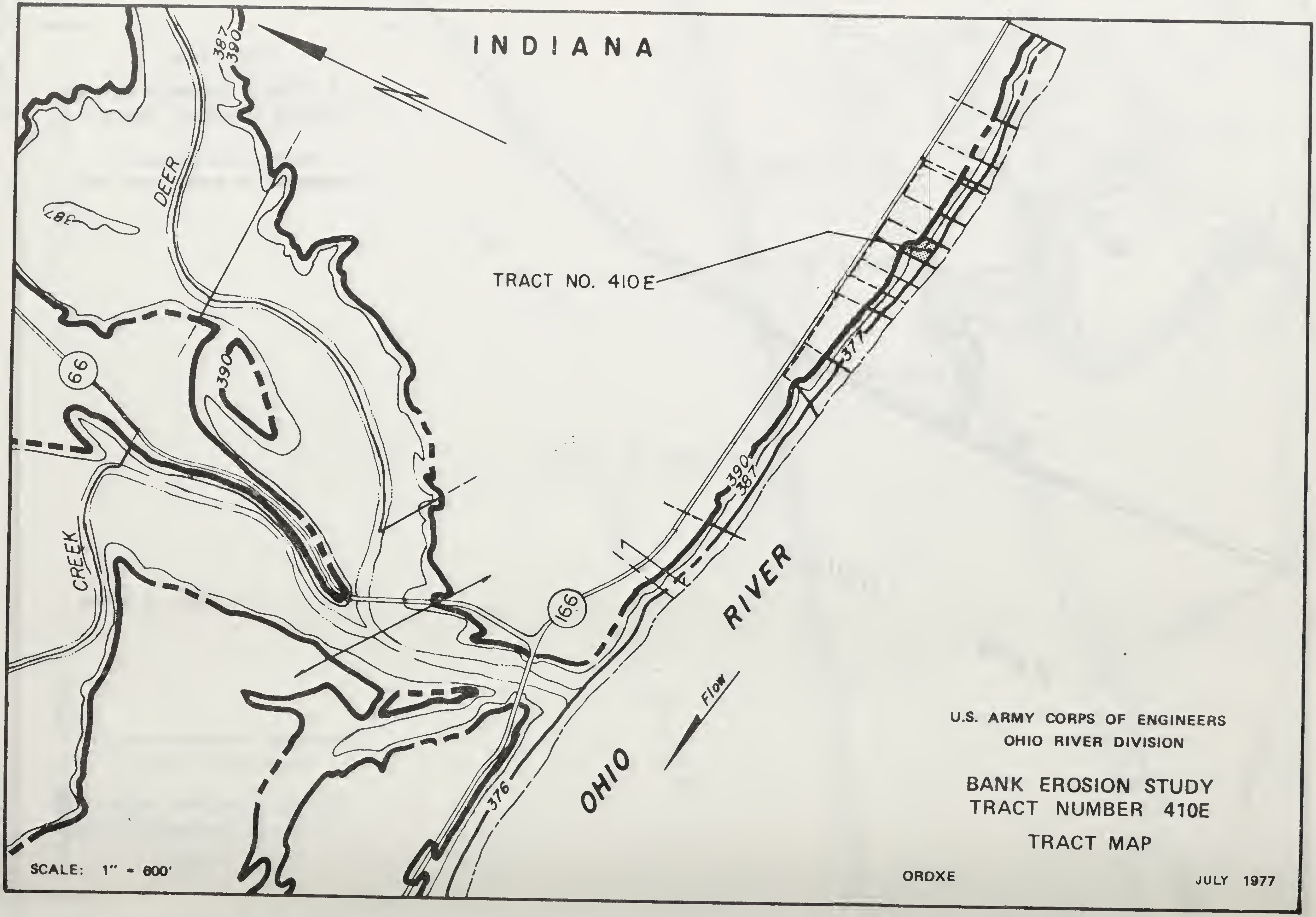
ORDXE JULY 1977

PLATE A–10



MILE 394
N
SCALE: 1" = 600'
OHIO RIVER
Flow
TRACT NO. 2102 E-1
TRACT NO. 2102 E-2
C & O RR
KENTUCKY
U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY
TRACT NUMBER 2102E1 & E2
TRACT MAP
ORDXE
JULY 1977

PLATE A-11

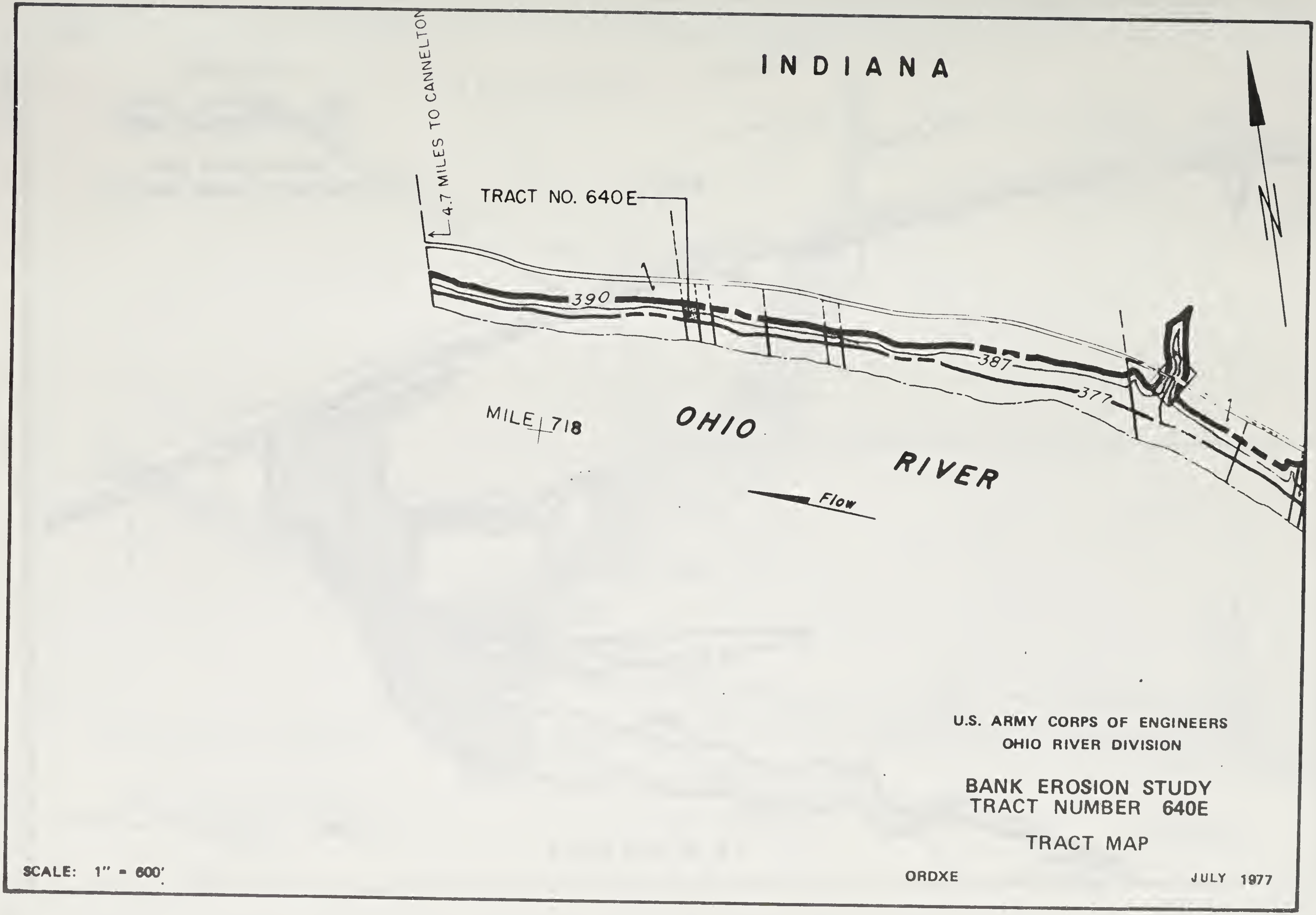


U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION

BANK EROSION STUDY
TRACT NUMBER 410E

TRACT MAP

PLATE A–12



INDIANA
4.7 MILES TO CANNELTON
TRACT NO. 640E
390
387
377
MILE 718
OHIO RIVER
Flow
U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY
TRACT NUMBER 640E
TRACT MAP
SCALE: 1" = 600'
ORDXE
JULY 1977

PLATE A–13

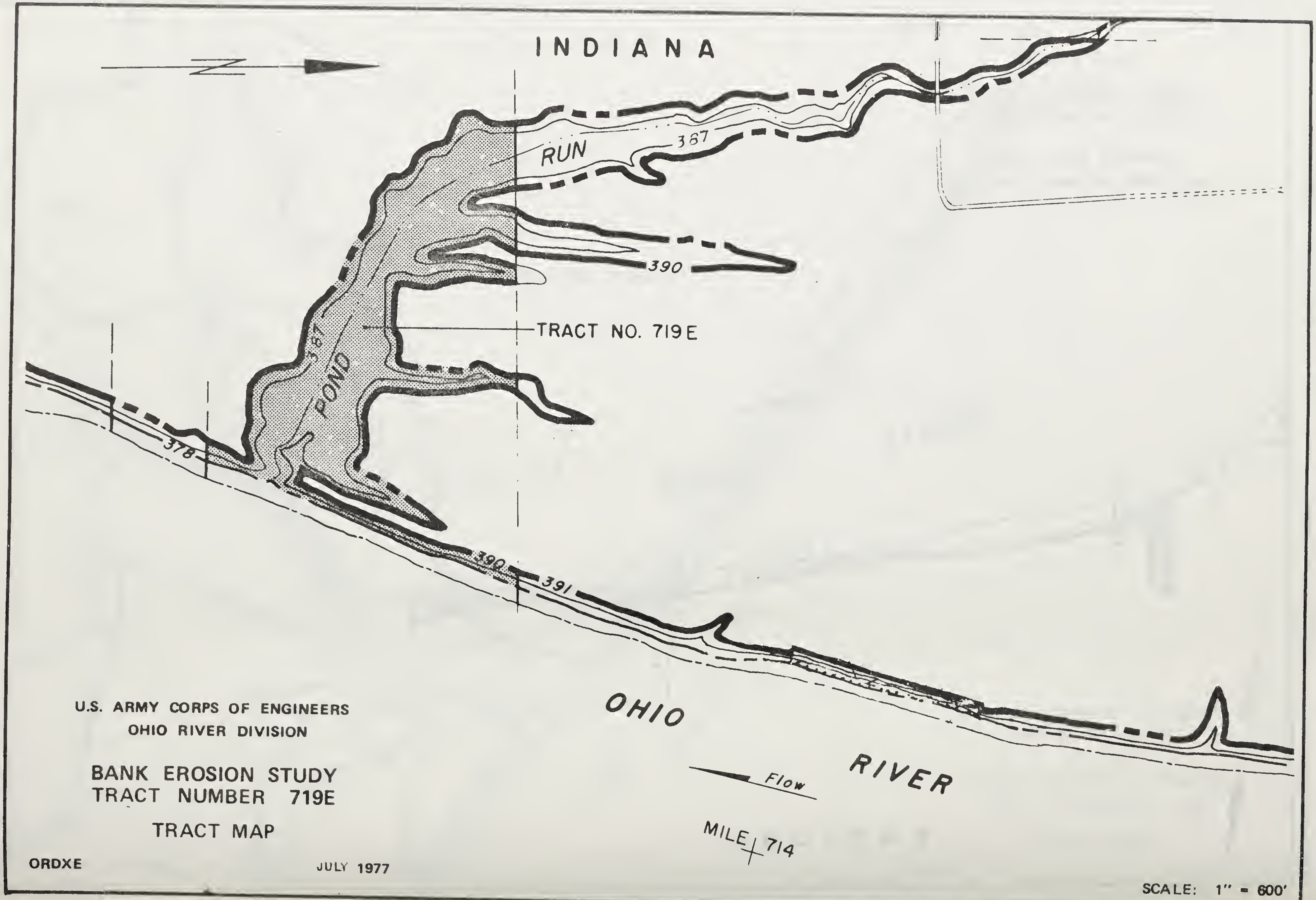
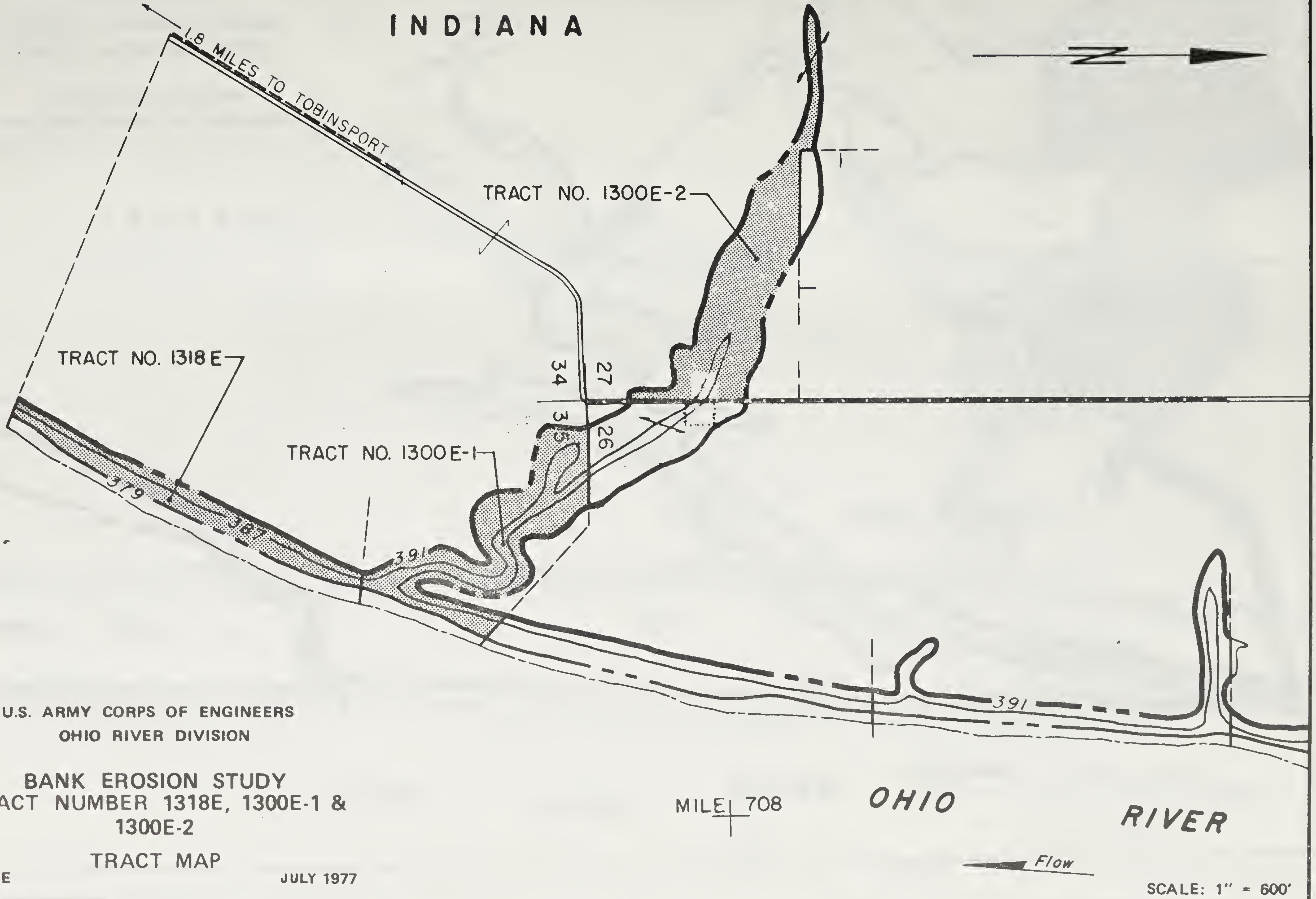

INDIANA
N
RUN
387
390
TRACT NO. 719E
387
POND
378
390
391
OHIO
RIVER
Flow
MILE 714
U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY
TRACT NUMBER 719E
TRACT MAP
ORDXE
JULY 1977
SCALE: 1" = 600'

PLATE A–14



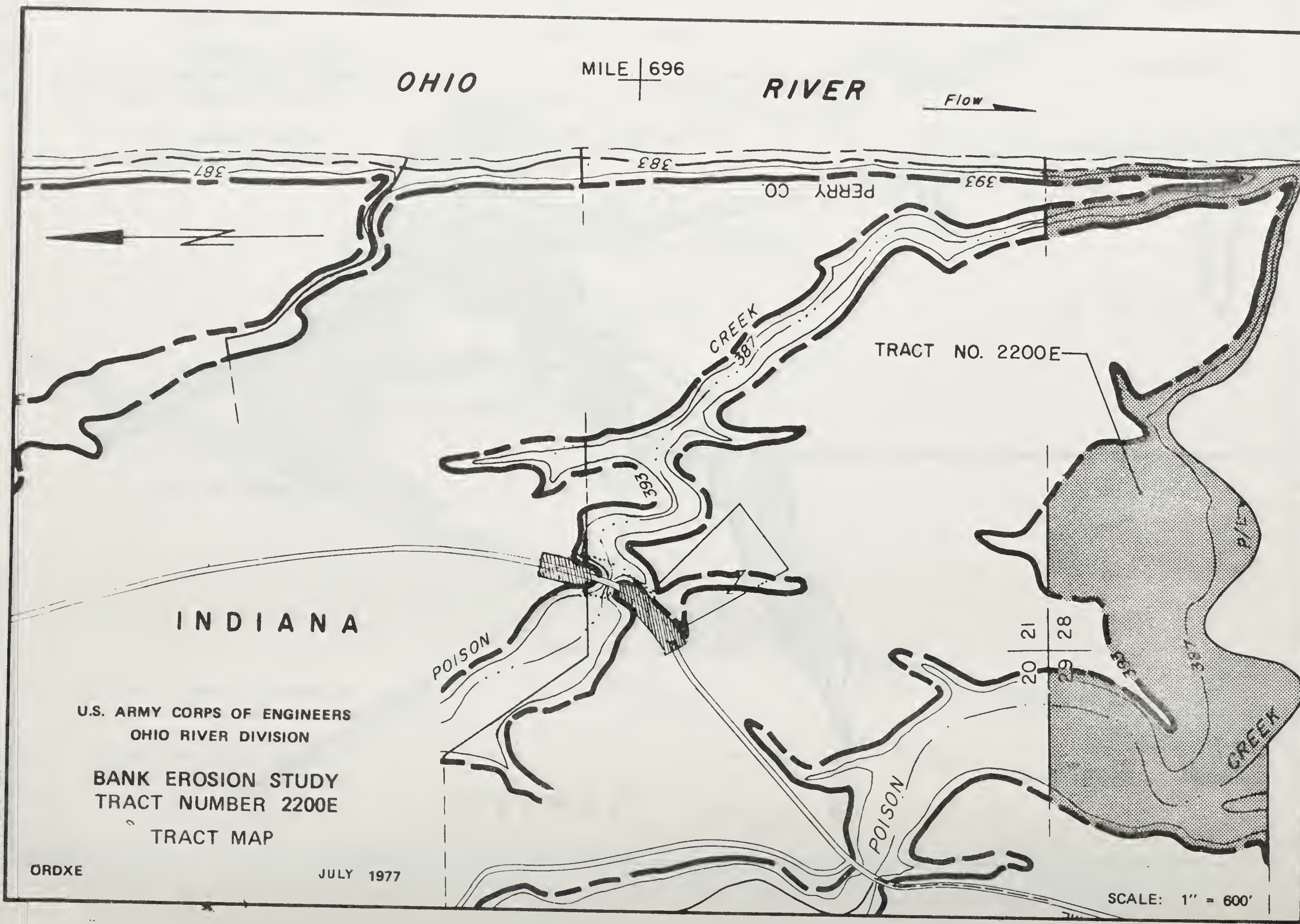
U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION

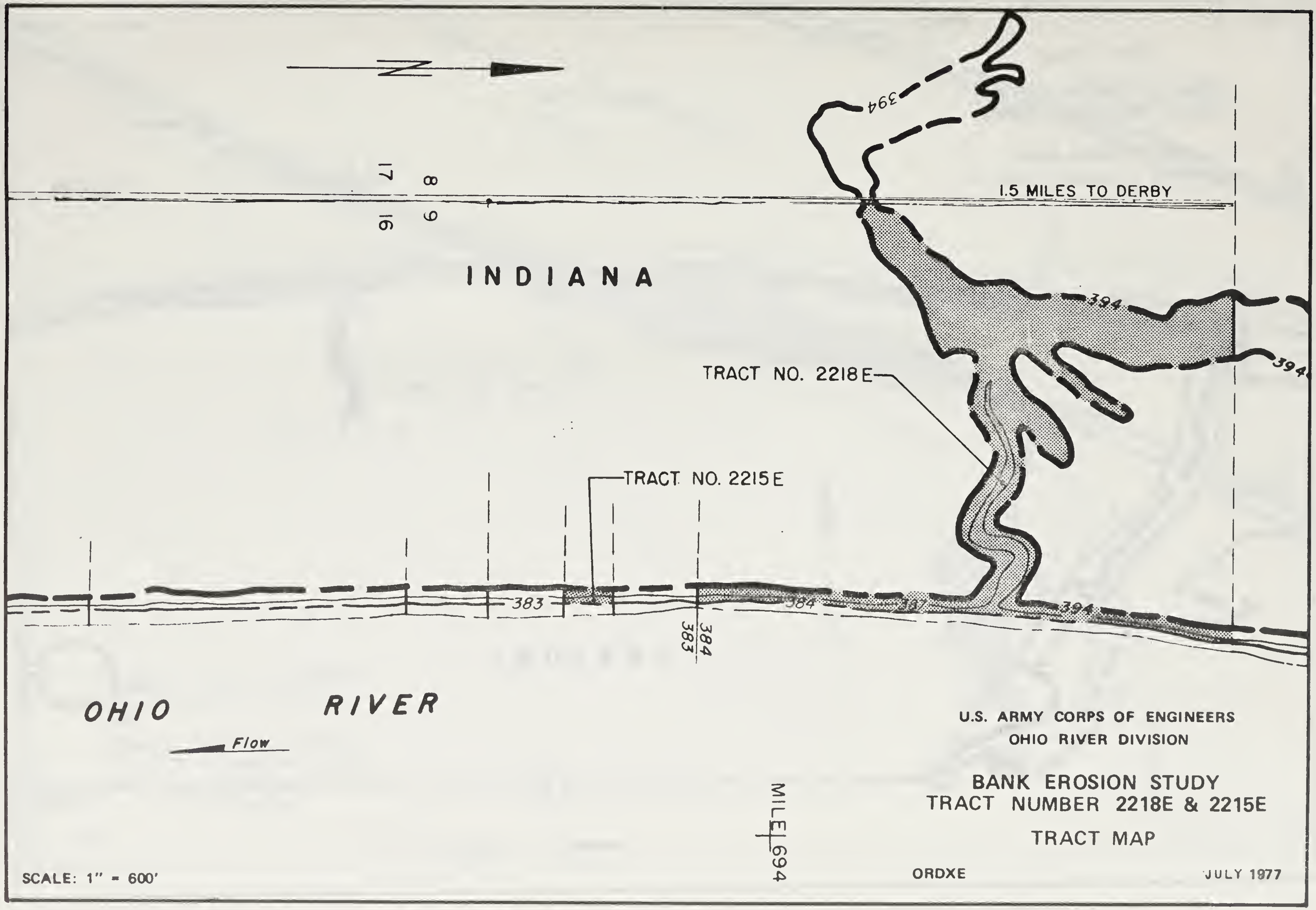
BANK EROSION STUDY
TRACT NUMBER 1318E, 1300E-1 &
1300E-2

TRACT MAP

ORDXE

JULY 1977


OHIO RIVER
MILE 696
Flow
387
383
393
PERRY CO.
CREEK
387
393
TRACT NO. 2200E
P/L
21
28
20
29
393
387
CREEK
INDIANA
POISON
POISON
U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY
TRACT NUMBER 2200E
TRACT MAP
ORDXE
JULY 1977
SCALE: 1" = 600'



1.5 MILES TO DERBY
394
17
8
16
9
INDIANA
TRACT NO. 2218E
TRACT NO. 2215E
383
384
387
384
383
OHIO RIVER
Flow
MILE 694
U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY
TRACT NUMBER 2218E & 2215E
TRACT MAP
ORDXE
JULY 1977
SCALE: 1" = 600'

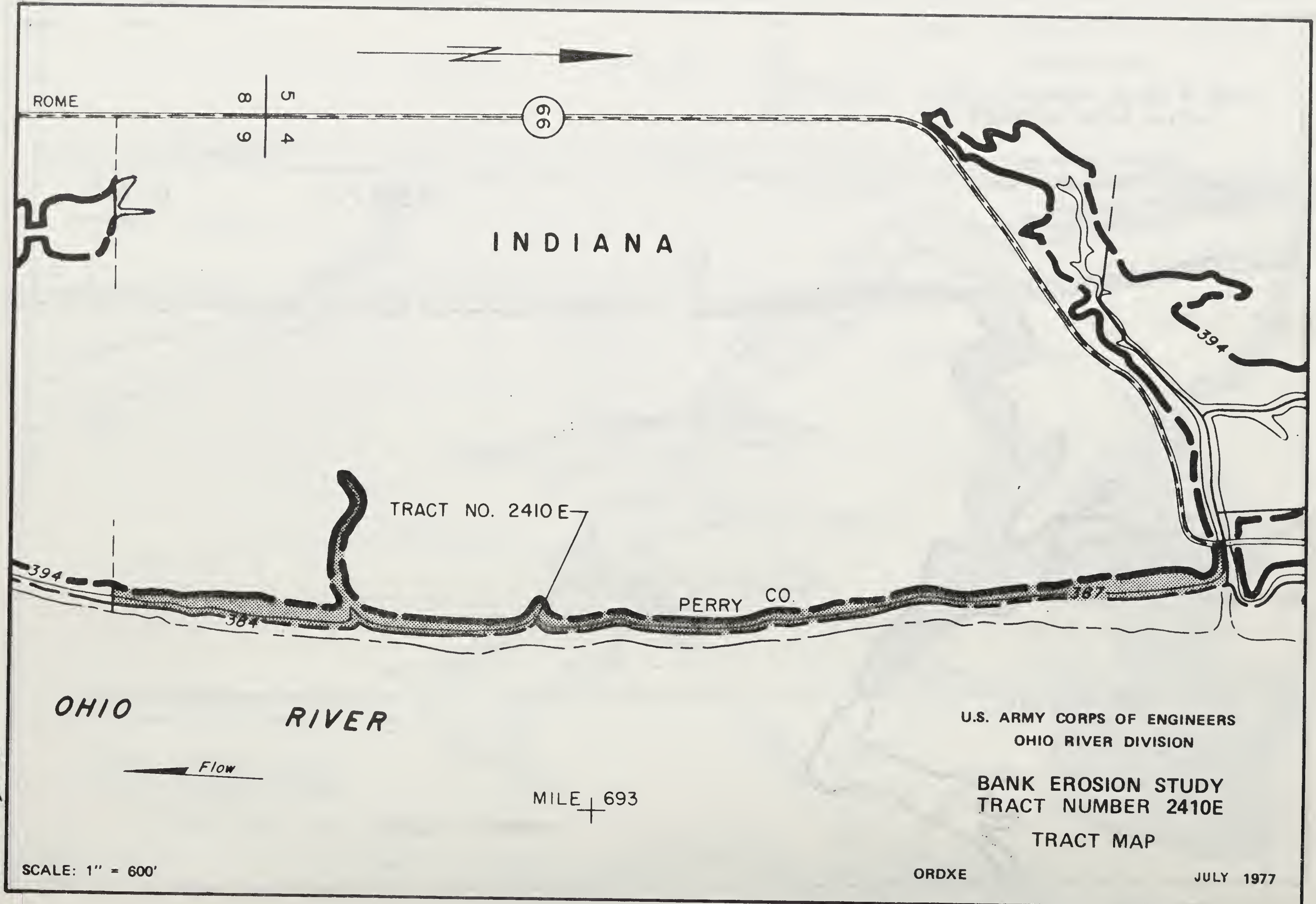
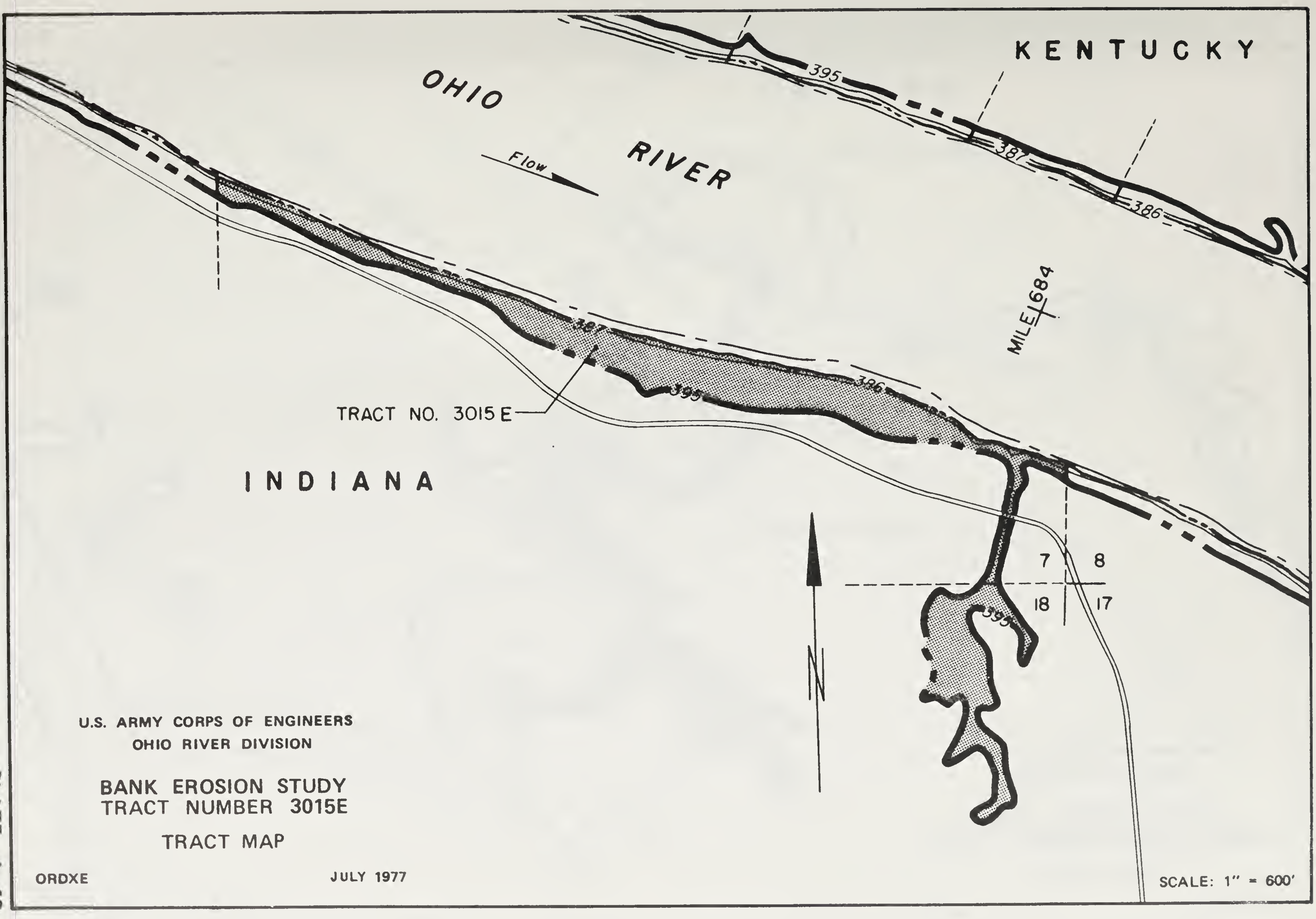
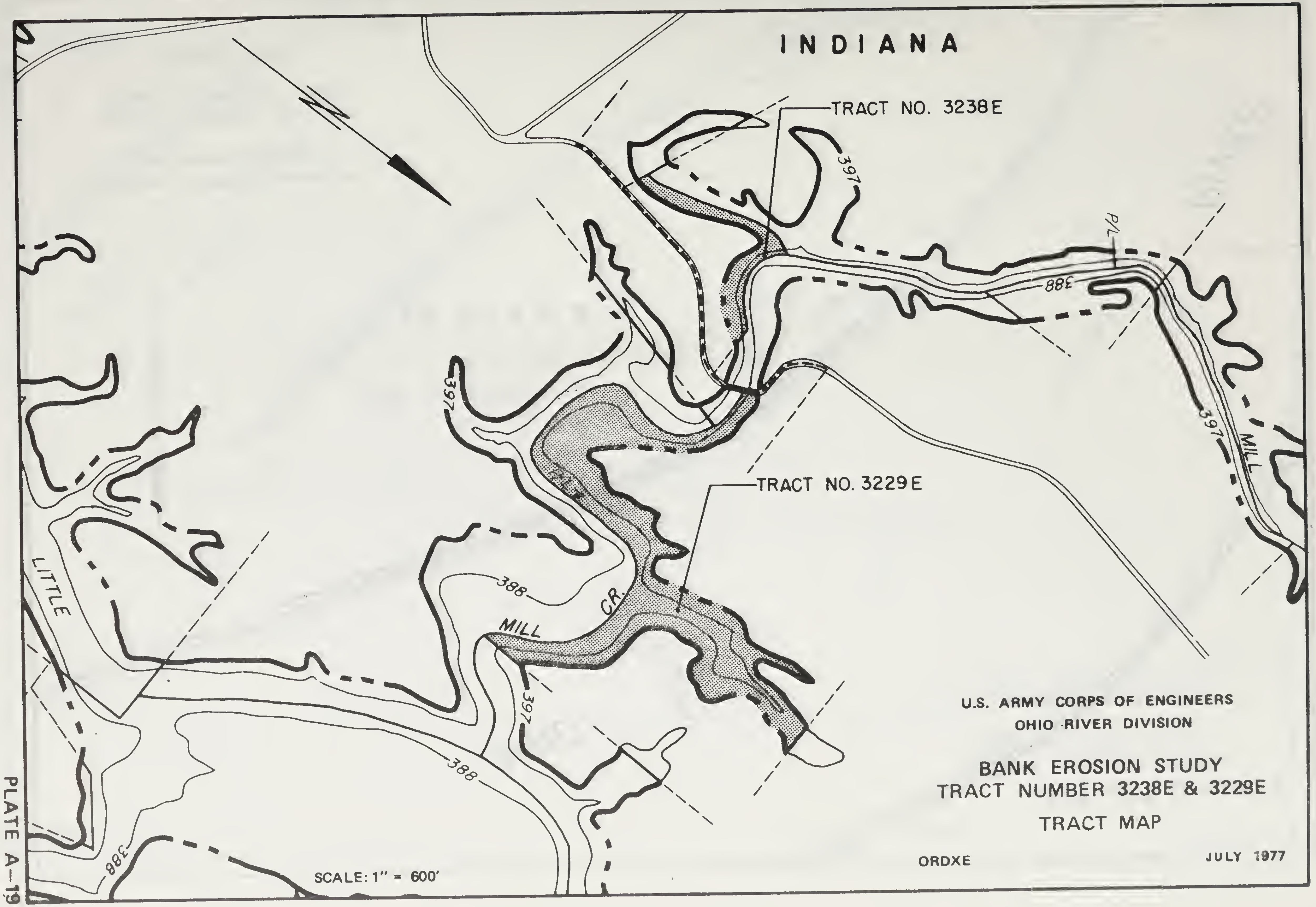

ROME
5
4
8
9
66
INDIANA
394
TRACT NO. 2410E
PERRY CO.
384
387
OHIO RIVER
Flow
MILE 693
U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY
TRACT NUMBER 2410E
TRACT MAP
SCALE: 1" = 600'
ORDXE
JULY 1977

PLATE A–17/1


KENTUCKY
OHIO RIVER
Flow
395
387
386
MILE 684
396
TRACT NO. 3015 E
INDIANA
7
8
18
17
N
U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY
TRACT NUMBER 3015E
TRACT MAP
ORDXE
JULY 1977
SCALE: 1" = 600'


INDIANA
TRACT NO. 3238E
TRACT NO. 3229E
P/L
397
388
MILL
MILL
CR.
LITTLE
SCALE: 1" = 600'
U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY
TRACT NUMBER 3238E & 3229E
TRACT MAP
ORDXE
JULY 1977

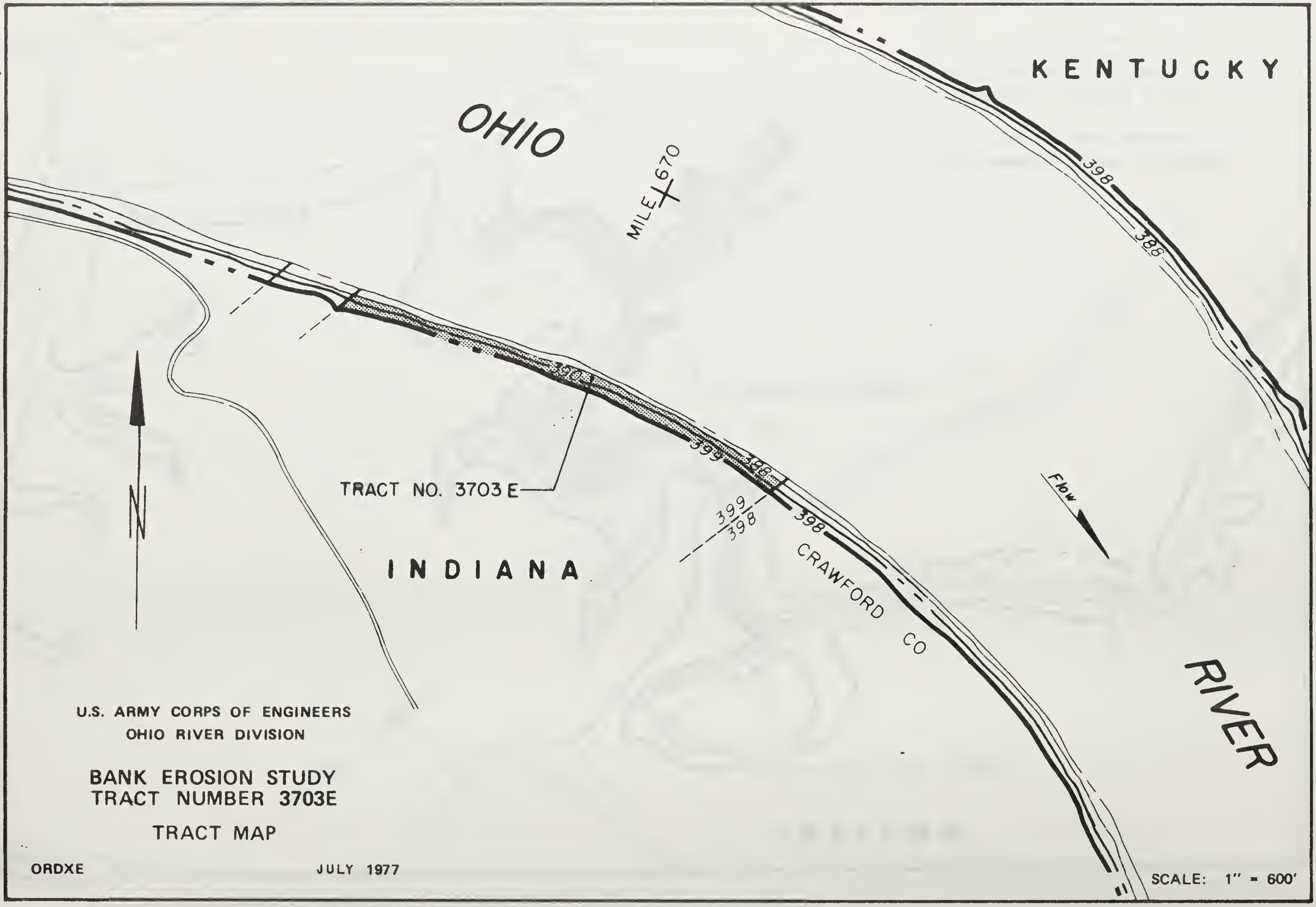
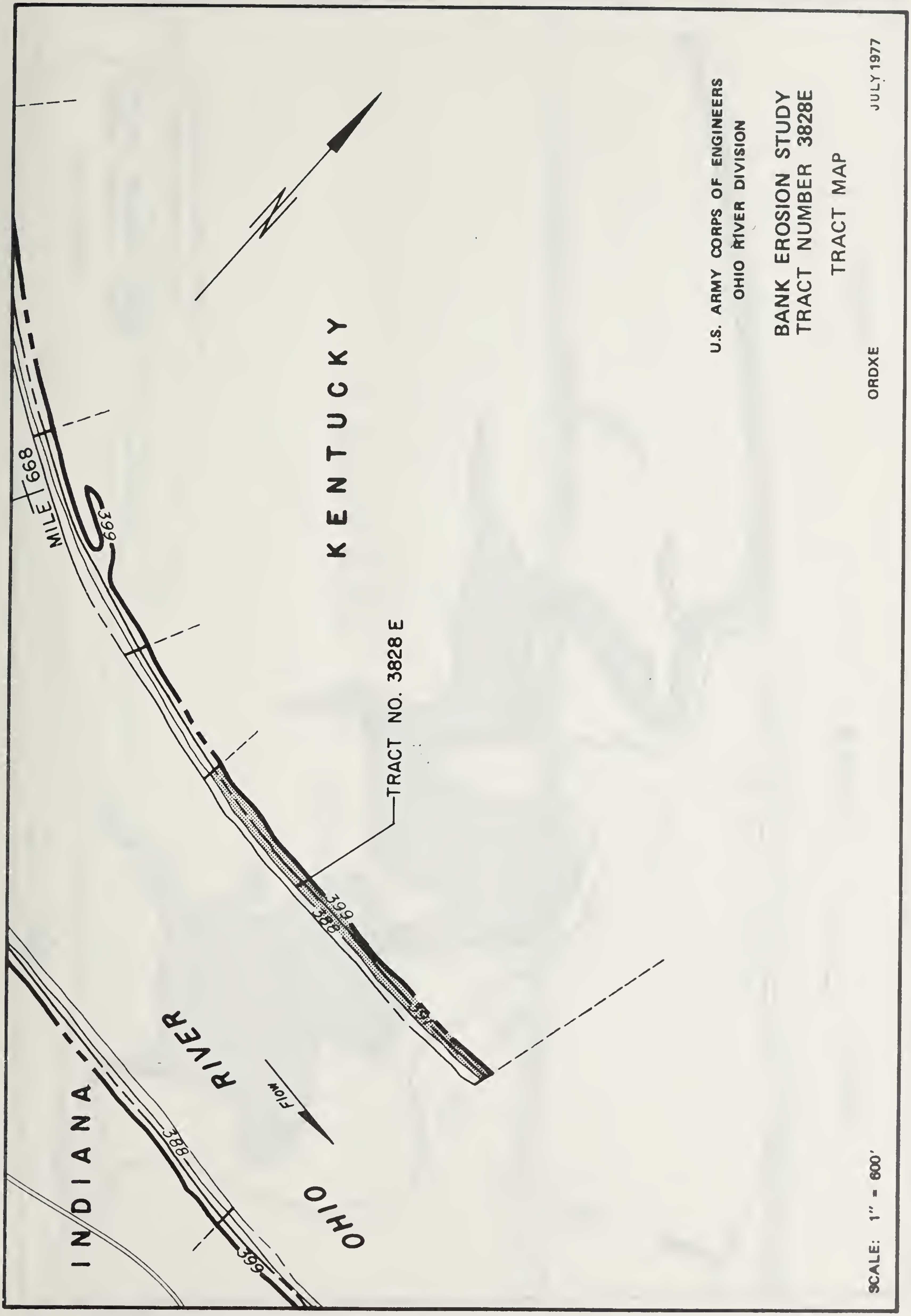

KENTUCKY
OHIO
RIVER
MILE 670
398
388
Flow
TRACT NO. 3703 E
399
398
CRAWFORD CO
INDIANA
N
U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY
TRACT NUMBER 3703E
TRACT MAP
ORDXE
JULY 1977
SCALE: 1" = 600'

PLATE A–20


U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY
TRACT NUMBER 3828E
TRACT MAP
ORDXE
JULY 1977
KENTUCKY
INDIANA
OHIO RIVER
FLOW
TRACT NO. 3828 E
MILE 668
399
388
SCALE: 1" = 600'

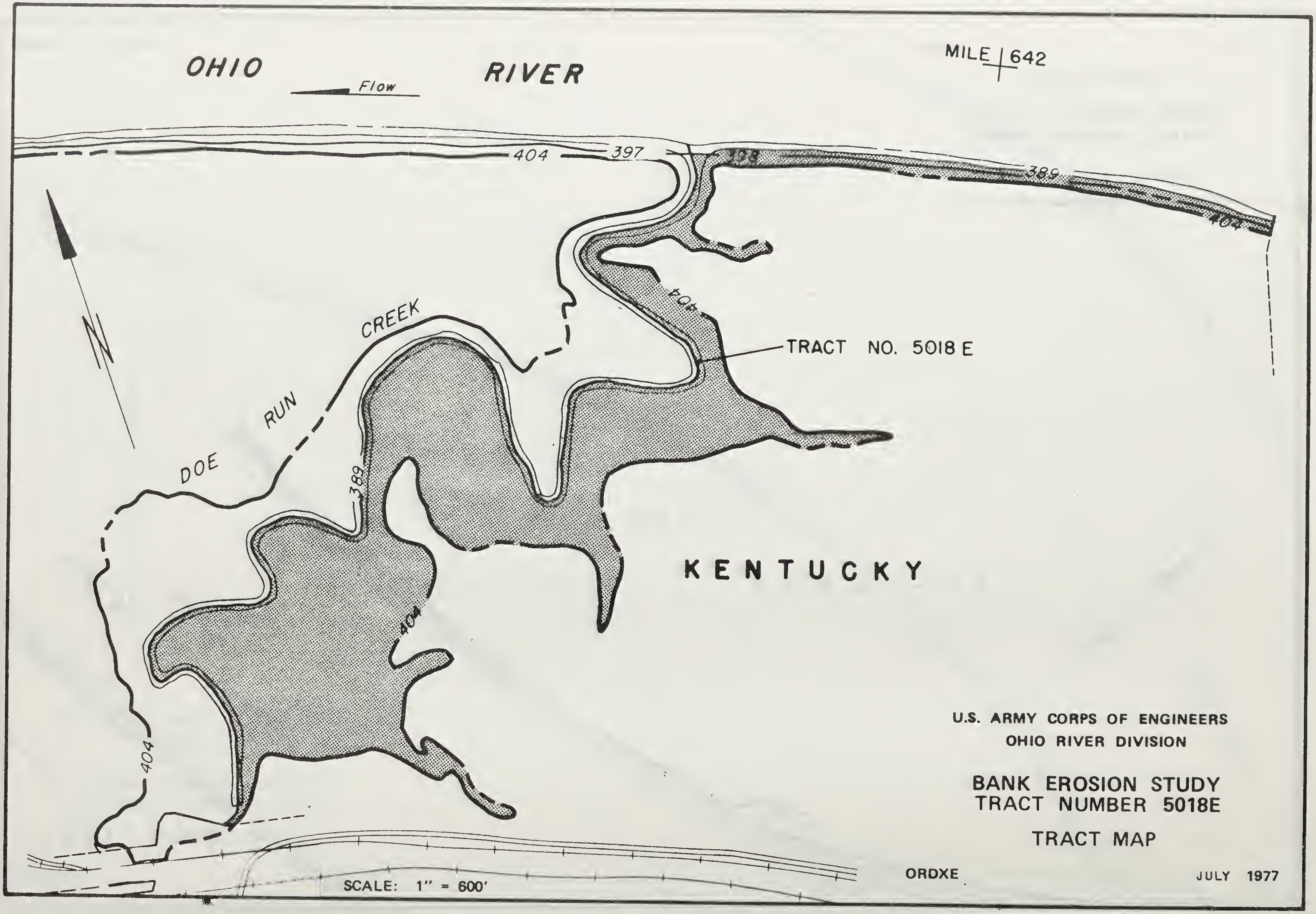

OHIO RIVER
Flow
MILE 642
404
397
389
404
TRACT NO. 5018 E
CREEK
RUN
DOE
389
404
404
KENTUCKY
U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY
TRACT NUMBER 5018E
TRACT MAP
ORDXE
JULY 1977
SCALE: 1" = 600'

PLATE A–22

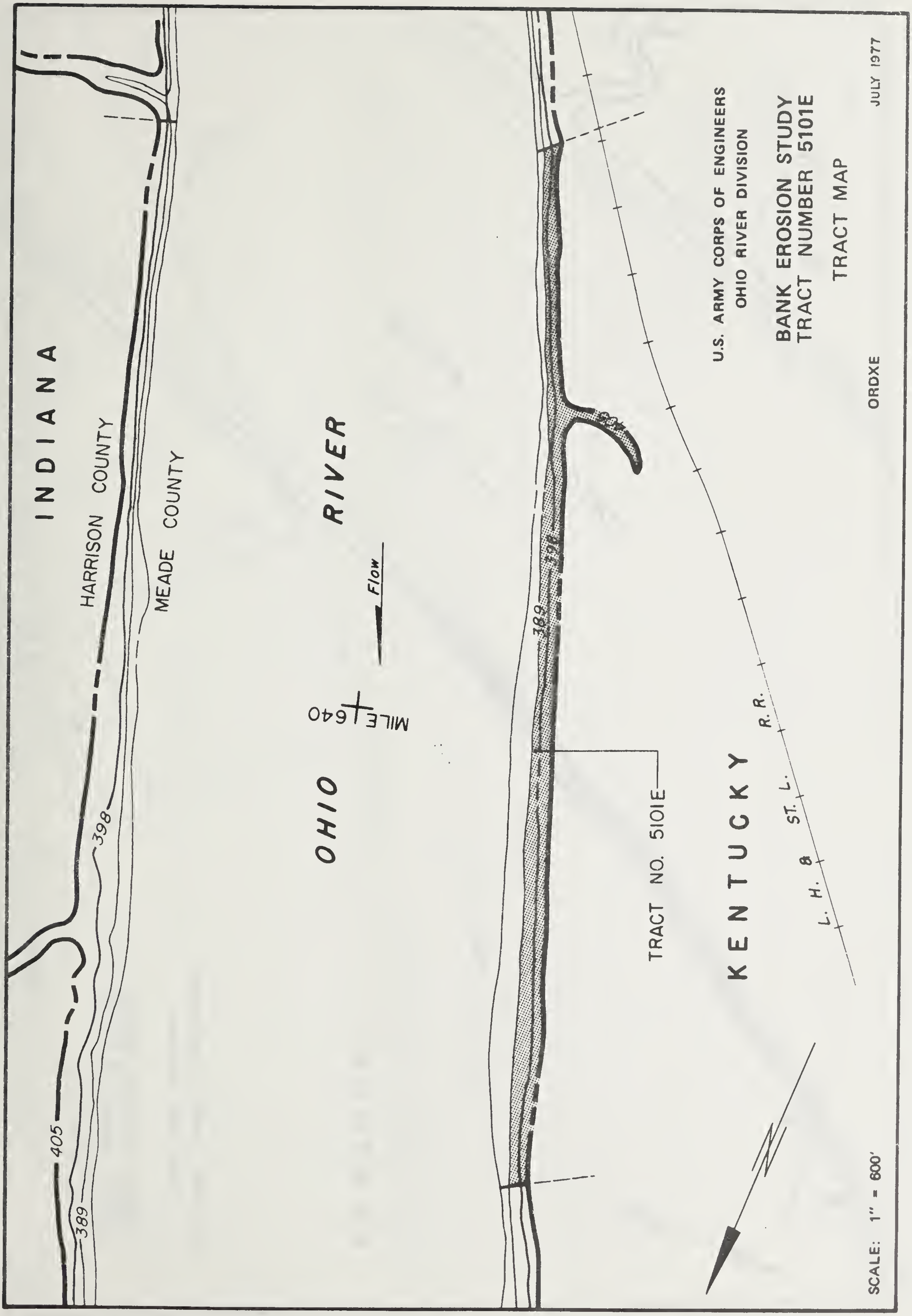
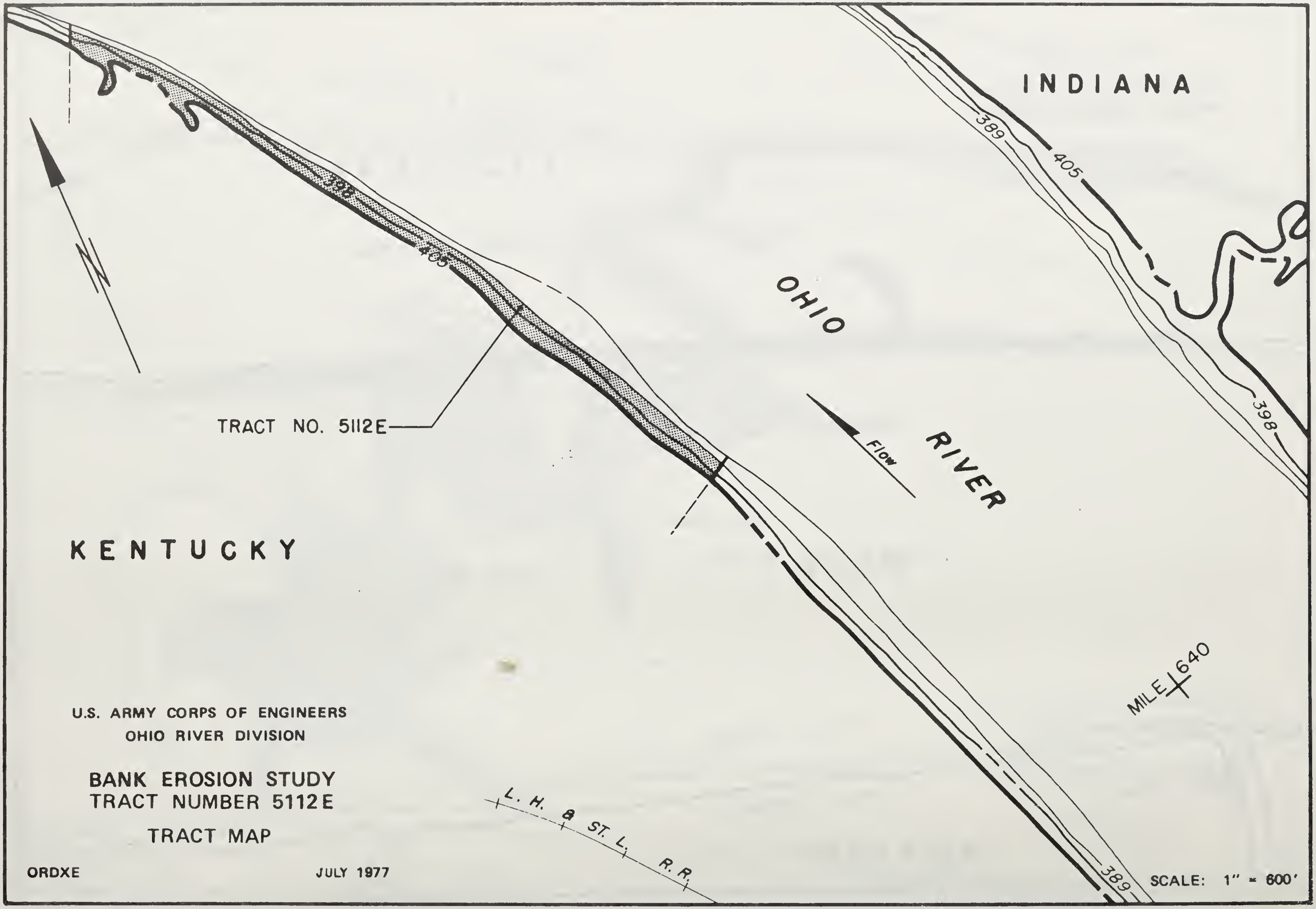
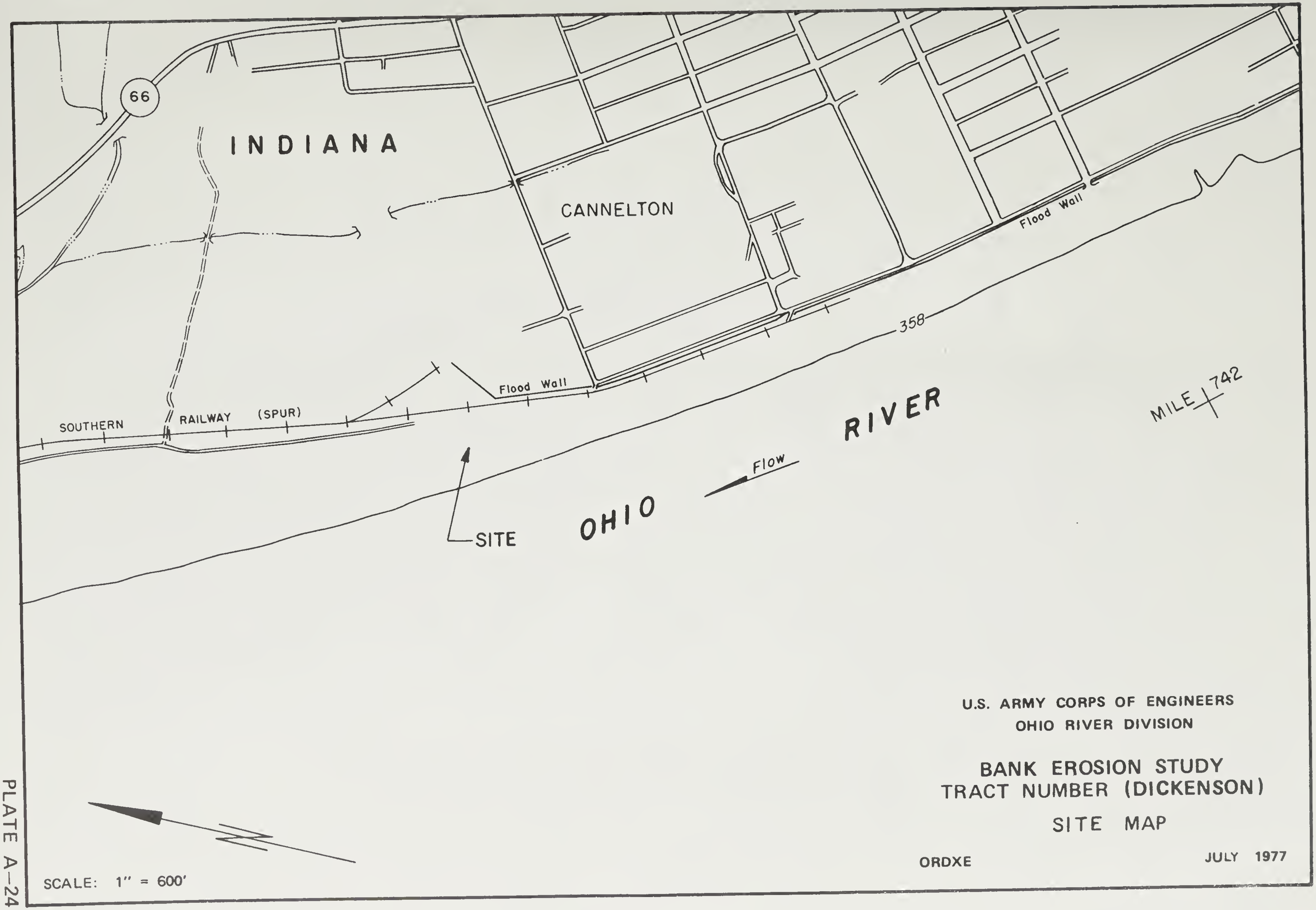

INDIANA
HARRISON COUNTY
MEADE COUNTY
OHIO RIVER
Flow
MILE 640
405
389
398
389
396
TRACT NO. 5101E
KENTUCKY
L. H. & ST. L. R.R.
U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY
TRACT NUMBER 5101E
TRACT MAP
ORDXE
JULY 1977
SCALE: 1" = 600'

PLATE A–23


INDIANA
KENTUCKY
OHIO RIVER
Flow
TRACT NO. 5112E
389
405
398
MILE 640
L. H. & ST. L. R. R.
U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY
TRACT NUMBER 5112E
TRACT MAP
ORDXE
JULY 1977
SCALE: 1" = 600'


66
INDIANA
CANNELTON
Flood Wall
Flood Wall
SOUTHERN RAILWAY (SPUR)
358
MILE 742
RIVER
Flow
OHIO
SITE
U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION
BANK EROSION STUDY
TRACT NUMBER (DICKENSON)
SITE MAP
ORDXE
JULY 1977
SCALE: 1" = 600'

APPENDIX B

GEOLOGY AND SOILS DATA

TABLE OF CONTENTS

FIGURES

APPENDIX B

GEOLOGY AND SOILS DATA

The data in this appendix were obtained from a number of sources, inclusive of historical files, published reports, mapping, profiles and cross sections, aerial photography interpretations, field reconnaissance and sampling and testing of materials.

The geomorphic setting for the study of streambank erosion conditions at the upper extent of the Newburgh Pool, within the Cannelton Pool, and within the Meldahl Pool reaches of the Ohio River is shown by Plate No. 1. The locations of pool-referenced reaches of the Ohio River studied are shown on Plate 5.

The Cannelton Pool area between the Cannelton Locks and Dam in southern Indiana and the McAlpine Locks and Dam at Louisville, Kentucky, lies entirely within the Central Lowlands Physiographic Province, while the Meldahl Pool between the Meldahl Locks and Dam located upstream from Cincinnati, Ohio, and the Greenup Locks and Dam lies partially in Central Lowlands, Interior Plateaus, and Appalachian Highlands Provinces. The character of the Ohio River Valley changes between the physiographic provinces with adjacent uplands structures having significant effects within the upper reaches of the Meldahl Pool. The Cincinnati Arch structure and its extension southward into Kentucky form a dome centered at Lexington. This dome is ringed by an escarpment known variously as "The Knobs" in Kentucky, the "Knobstone Escarpment" in Indiana, and southwest of Louisville as "Muldraugh's Hill." This escarpment extends northeastward and defines by rock strata of different ages the various segments of the Meldahl Pool.

Changes in landforms and realignment of drainage patterns during the Pleistocene Epoch are significant to the present study since these changes are associated with the forming of the Ohio River Valley and the deposition within that valley of materials which are presently undergoing erosion.

A number of investigations have been conducted regarding the origin and characteristics of the bedrock defined Ohio River Valley and the alluvial materials which have been deposited in that valley. An example reference is "The Deep Channel and Alluvial Deposits of the Ohio Valley in Kentucky," by E. H. Walker, Geological Survey Water-Supply Paper 1411, United States Government Printing Office, Washington, 1957. Plates 2, 3, and 4 have been derived from this paper and indicate the extent of valley development and the characteristics of fill materials.

The glacial lowerings of sea level resulted in erosion of bedrock to present depths, creating a gradient appreciably steeper than that of the present river. Alluvial materials were then deposited during the retreat of Illinoian glaciation. Wisconsin events removed most of these deposits, leaving only terrace remnants. During the Tazewll-Cary interval of glacial recession, sand and gravel outwash from melting Wisconsin glaciers was deposited. The meltwater volume and flow velocities were sufficient to move fine-grained materials such as clay, silt and fine sand downriver, leaving deposits of boulders, cobbles, pebbles and coarse sand. These coarse-grained deposits are generally continuous. Thin lenses or layers of silt or clay, indicative of temporary backwater conditions are also encountered. Thus the median grain size of materials deposited by glacial meltwaters generally decreases both in a downriver direction and with increasing elevation. The thickness of this alluvial fill increases from 25 feet at Ashland, Kentucky, to 110 feet at Paducah, Kentucky. However, the vertical extent of this coarse alluvium is extremely irregular, indicating that subsequent erosion events have occurred.

During the final melting of the Wisconsin ice sheet, a thick layer of fine-grained alluvium was deposited over coarse basal materials. These fine-grained sediments are characteristic of the materials presently being eroded and transported within the valleys of the Ohio River and tributaries. Such deposition of fine alluvium has continued to occur whenever the river falls from major flood stages. These sediments were initially deposited as a result of rises in water levels along the Mississippi River. These rises in water level occurred as a result of rises in sea level as glacial melting occurred, and as a result of delta formation in the downstream reach of the Mississippi River.

In some of the tributary valleys adjacent to the river, lakes were formed as a result of the temporary damming of streams during glacial periods. Laminated silt and clay deposits have been encountered in many of these valleys in western Kentucky and southern Indiana.

As mentioned previously, the advance of the glaciers into the area immediately to the north of the Ohio River Valley, and in some instances into the valley itself, caused significant physiographic alterations. Prior to the Pleistocene Epoch the Ohio River, according to the judgment of some geologists, originated in the vicinity of Cincinnati and flowed south and west along the general route of the present river. Many geologists are of the opinion that the Ohio River flowed south-westerly during pre-glacial times from the vicinity of West Point, Kentucky, with a drainage divide being located approximate to the Knobstone

Escarpment. As a result of dammings of northerly flowing rivers during the advance of glacial ice, these waters were diverted from the pre-glacial Teays River, and its tributaries and joined with the Licking River, the Miami River, and the Kentucky River to flow southward and westward through the valley of the present Ohio River. Remnants of this ancient river valley in the vicinity of Cincinnati and southwestward toward Madison, Indiana, are observed to contain terraces approximately 200 to 300 feet above the level of the present Ohio River. To the east, a drainage divide existed at Manchester, Ohio, and in the vicinity of Portsmouth, Ohio, and a pre-glacial river flowed northward to the Teays River which then flowed north and west through Ohio, Indiana and Illinois. These dammed rivers filled pre-glacial valleys until the water level overtopped the elevation of drainage divides. After the glacial ice melted, the pre-glacial valley was filled with sediment, and the water courses which previously had flowed north and west in the Teays River system flowed westward within the new Ohio River system.

Differences of opinion also exist as to the time sequence involved in rearrangements of drainage patterns in the central Ohio Valley, and the determination of which glacial advance first rearranged the drainage of the then northern-flowing tributaries of the Ohio River. These chronological controversies are not significant to the present studies, but the impacts of the rearrangements of drainage which occurred during the Pleistocene Epoch are of considerable importance.

The characteristics of the present alluvial valley of the Ohio River are shown on Plate Nos. 2 and 3. These exhibits define valley widths and constrictions downriver from the confluence of the Salt River where more resistant rock was eroded. Bedrock controls exert a more significant effect on the present Ohio River in the Meldahl Pool and this central one-third reach of the Cannelton Pool than in the remainder of the Cannelton Pool. Also of importance are the valley characteristics downriver of Leavenworth, Indiana, where abandoned meanders are located.

The post-glacial history of the river valley has been described by Walker:

> "Downcutting by the Ohio River and removal of much of the Wisconsin alluvial fill are the principal features of post-glacial history, ... Along the course of the valley the bed of the Ohio River now lies 75 to 115 feet below the original level of the Wisconsin fill. In meandering from side to side during the lowering, the river eroded the alluvium

throughout most parts of the valley, so that only at a few places is alluvium left as high as its original upper level.

In its natural state, before the construction of locks and dams for navigation, the profile of the river probably attained a condition of near-equilibrium. There is no strong evidence that the river was neither aggrading or degrading its bed. The main activity of the river was the gradual shifting of the channel, in which cutting on one side was partly compensated by deposition on the other."

Of particular importance to the present study of bank erosion are the sections taken through the river valley at ORM 471 and ORM 631 as shown on Plate 4. These sections shown on Plate 4 indicate that river valley width and depth vary considerably, depending on the circumstances of historical development and bedrock type. As has been noted, in the Meldahl Pool reach the river flows through a sequence of shales and shaly limestones, with the limited width of valley reflecting the relative resistance of these rocks to erosion. The river valley is also quite narrow where drainage divides previously existed, as at Manchester, and in the area immediately southwest of Cincinnati. The river valley is wider where significant tributaries or pre-glacial streams have flowed. In the upper section of the Cannelton Pool, the valley is wide where the river flows through a lowland eroded in soft shales of late Devonian and early Mississippian Ages. A few miles downstream from West Point, Kentucky, where the river flows on massive limestone of Mississippian Age, the valley narrows.

Investigations of a number of sites during this study indicate that the characteristics of the bank materials are extremely variable from one site to the next, at various elevations and from point to point on the bank, some perhaps only inches apart. At some sites, the alluvial materials are found in layers of only a few hundredths of an inch. At others, the thickness of some strata approaches tens of inches. In many exposures examined during this study, the bank materials have been found to have slumped or to have been disarranged by mass movements. In many instances, slumped areas with jumbled and distorted layering have been covered by subsequent deposition. The irregular interbedding of fine-grained clayey silts and silts with coarser layers of sand result in variations in the permeability characteristics of bank materials. In some areas, hydraulic connections occur between the river and the void spaces in materials within and underlying existing banks. In other areas, layers of impermeable clayey silts have been deposited or have

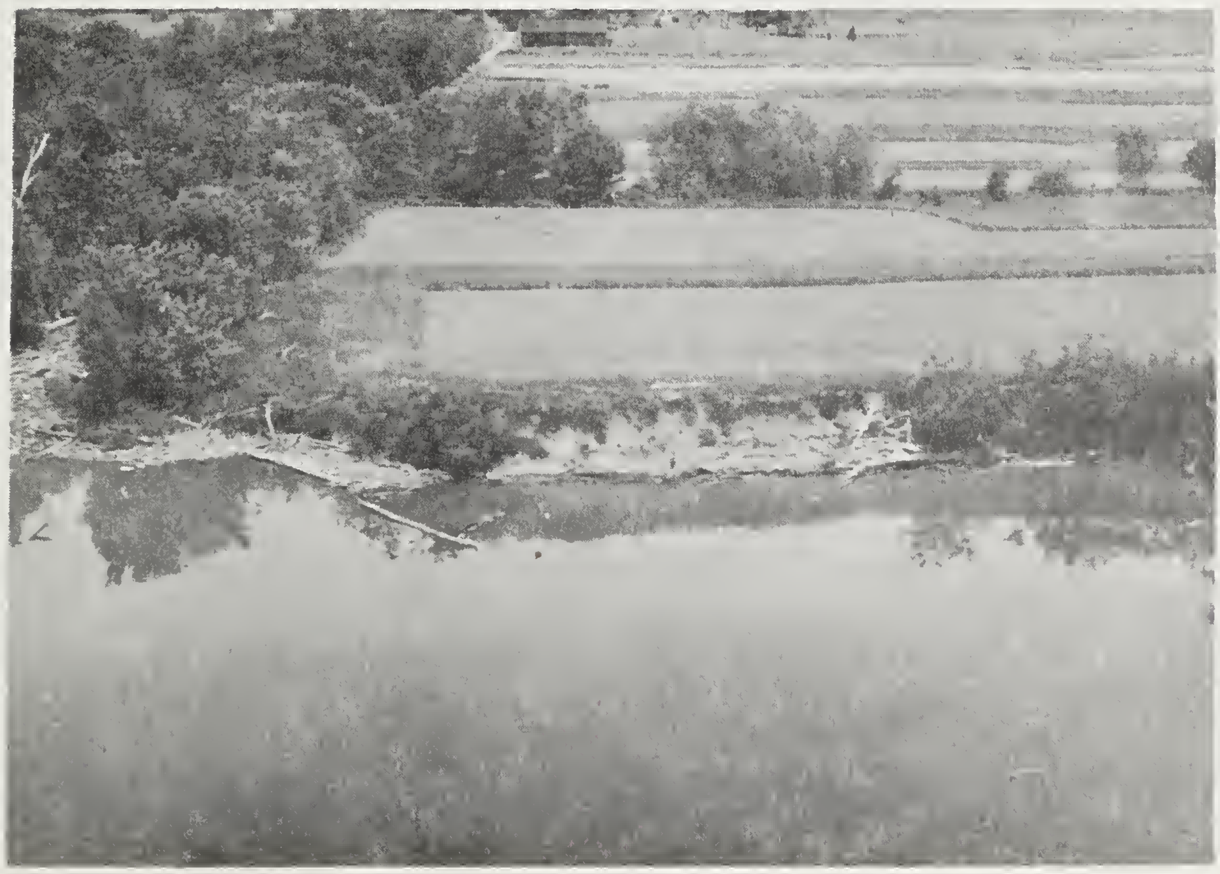
slumped to form a barrier between more pervious materials and the river. The irregularity of hydraulic connections between these materials, especially the relatively pervious sandy lenses, and the river creates complex water flow and water pressure conditions, with resulting bank instability.

The hillsides above the alluvial terrace deposits are generally mantled with displaced soils derived from weathering of the underlying shale, limestone and sandstone bedrock. These soils are termed colluvium, and differ markedly in properties and characteristics from the water-deposited alluvial valley fill. This colluvium consists of a clayey matrix with silts, sands and rock fragments. The steep hillsides and other conditions where the resistance of materials to sliding is reduced results in down-slope movements. The rate of movement is generally slow, but the margin of stability is seldom large and substantial slope failures are frequent.

Geologic, physiographic, and geomorphic conditions have been described in detail in the Environmental Study Report of the Cannelton Locks, Dam and Pool on the Ohio River, prepared by the University of Louisville Interdisciplinary Environmental Study Team for the Louisville District Corps of Engineers.

A

Approximate to downstream boundary of tract.
Note drift accumulations. 24 May 1977



B

Area of recent bank erosion and sample
site. 24 May 1977

C

Recent erosion at upper bank and benching
within debris at toe 10 May 1977

D

Sample site with excavated undisturbed
sample in-situ.

Figure B-1-1

E Rice
Tract 523E

E

Reach of bank approximate to Rice and Poston tract boundaries. 10 May 1977.

F

Drainway evidencing Ohio River backwater conditions. 10 May 1977

Figure B-1-1

A

Looking downstream at Rice - Poston - Rice
Tracts. 24 May 1977

B

Approximate to upstream tract boundary
showing sample site. Note vegetation
in shallows. 24 May 1977

Figure B-1-2

C

Sample site. Note exposed root systems.
10 May 1977

D

Approximate to downstream tract boundary.
Note acquatic vegetation in shallows.
24 May 1977

Figure B-1-2

C. & J. Rice
Tract 533 - 1 & 2

A

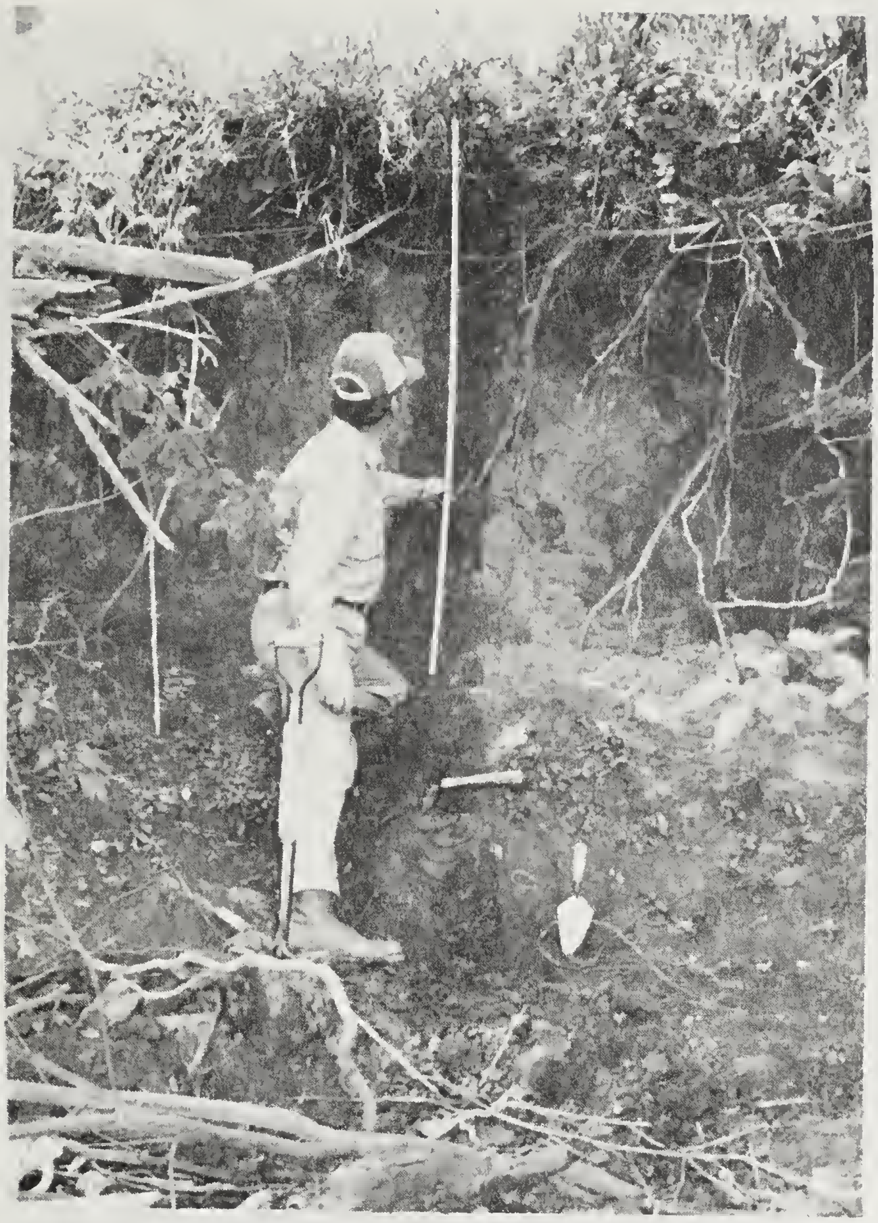
Approximate to downstream tract boundary.
Note fill and dumped rock.
24 May 1977

B

Approximate to upstream tract boundary showing erosion scarps and sample site. 24 May 1977

Figure B-1-3

C. & J. Rice
Tract 533 E - 1 & 2



C

Bank area and drift at sample site.
10 May 1977

D

Mid-tract reach of bank showing erosion scarps and drift accumulations. 24 May 1977

Figure B-1-3

A

Bank at sample site. Note colluvial debris. 24 May 1977

B

Sample site showing colluvium. 10 May 1977

Figure B-1-4

N. & A. Wood
Tract 1209 E

C

Dumped stone with colluvium derived rock debris. 10 May 1977

D

Reach of bank looking upstream from Wood tract. 10 May 1977

Figure B-1-4

D. & M. McNelly
Tract 1301 E

A

Reach of bank looking upstream from McNelly tract at Chouinard and Schwab Tracts. 24 May 1977

B

Recent slumpage scarps in bank at sample site. 24 May 1977

Figure B-1-5

D. & M. McNelly
Tract 1301 E

C

Preparation of undisturbed sample in-situ at sample site. 11 May 1977

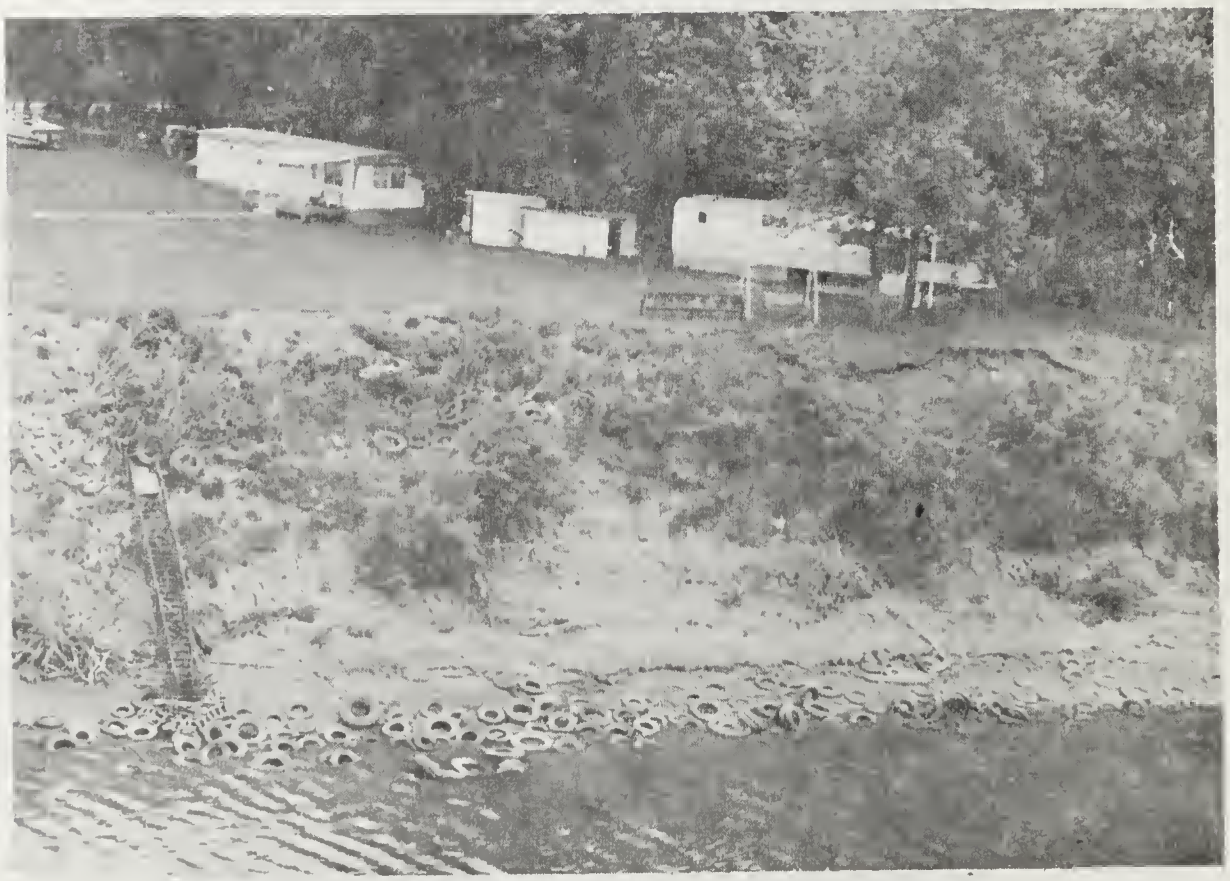
D

Figure B-1-5

J. & C. Chouinard
Tract 1305 E

A

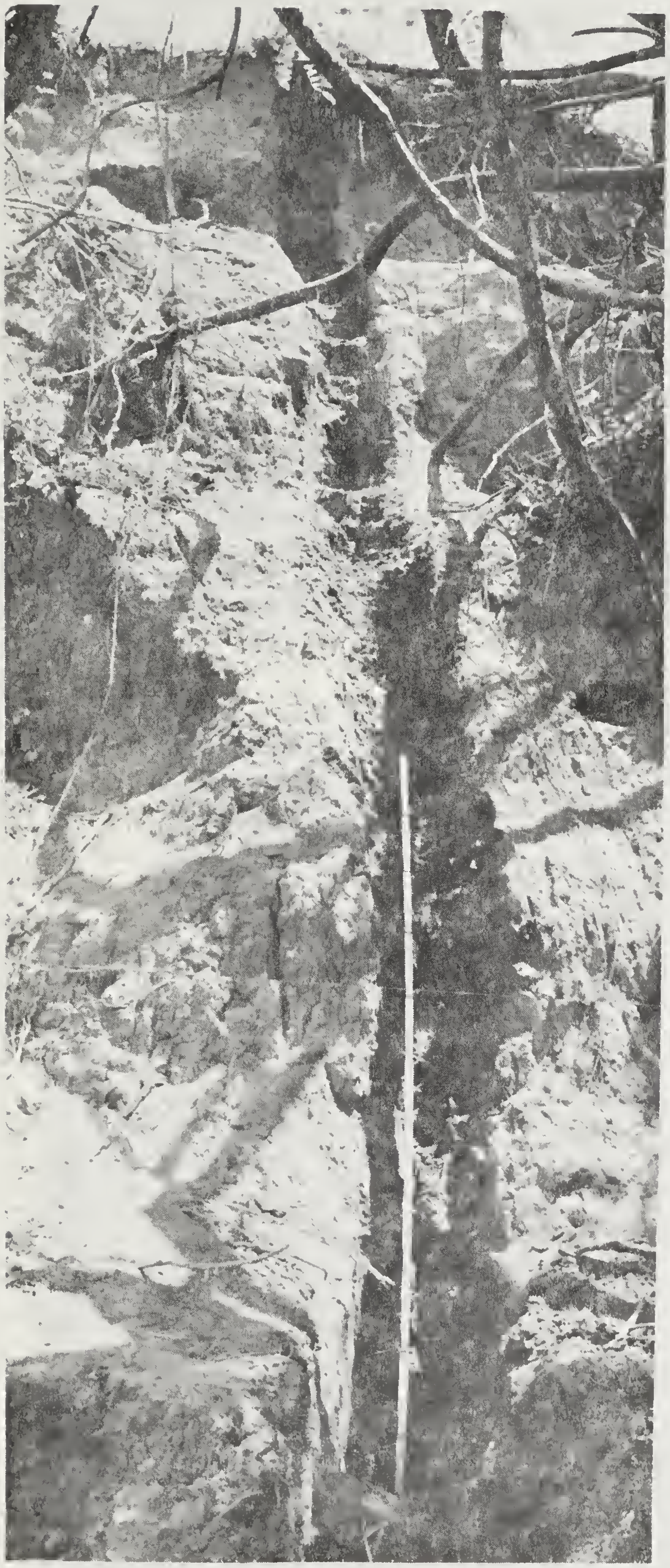
Upstream area of tract and at sample site approximate to confluence Ohio River and Three Mile Creek.
24 May 1977



B

Reach of bank approximate to structures and sample site. Note recent slumpage scarps at top of bank.
24 May 1977.

Figure B-1-6



C

Sample site approximate to Three Mile Creek. Note bedded fine sand deposit exposed in trench for upper five feet of bank. 12 May 1977

Figure B-1-6

J. & J. Schwab
Tract 1307 E

A

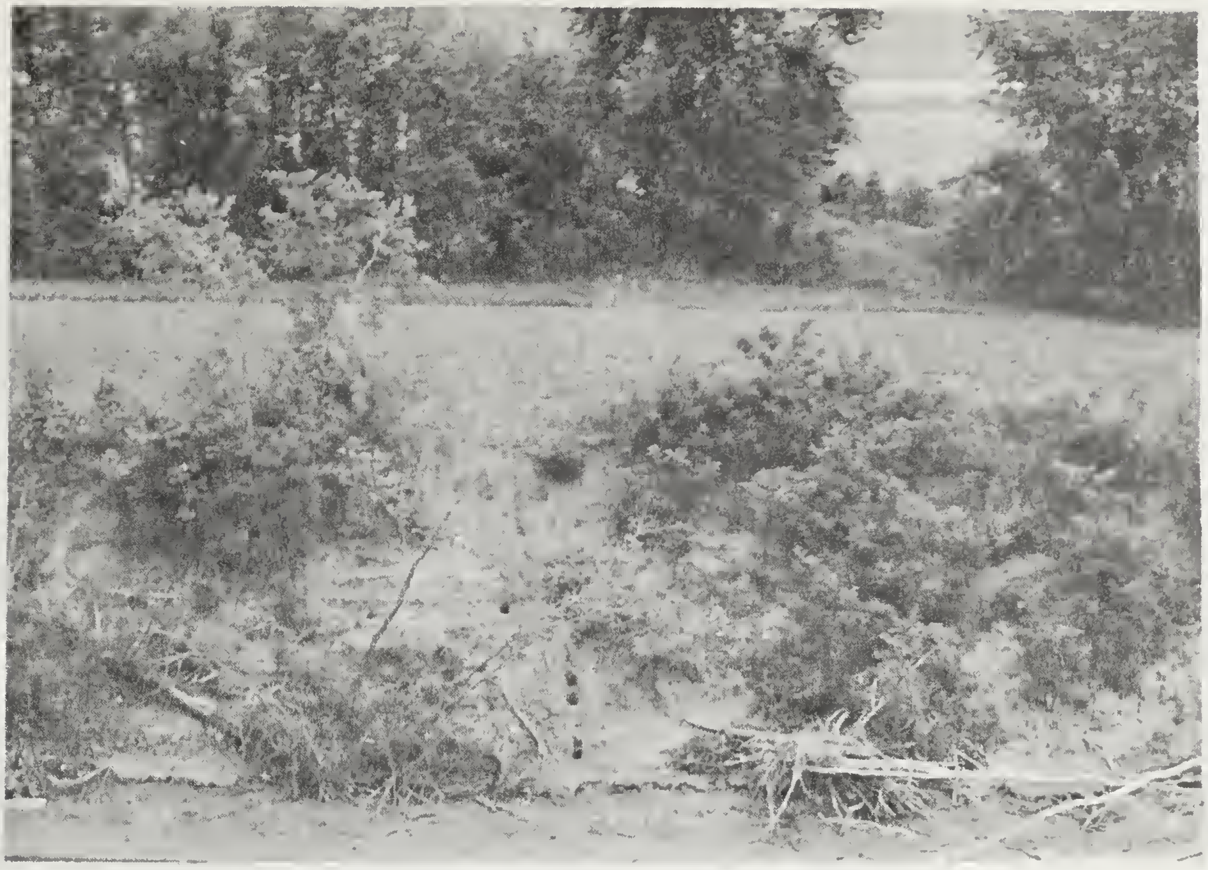
Upstream area of tract approximate to the confluence of Ohio River and Three Mile Creek. 24 May 1977

B

Three Mile Creek showing adjacent Schwab and Chouinald tracts. 24 May 1977

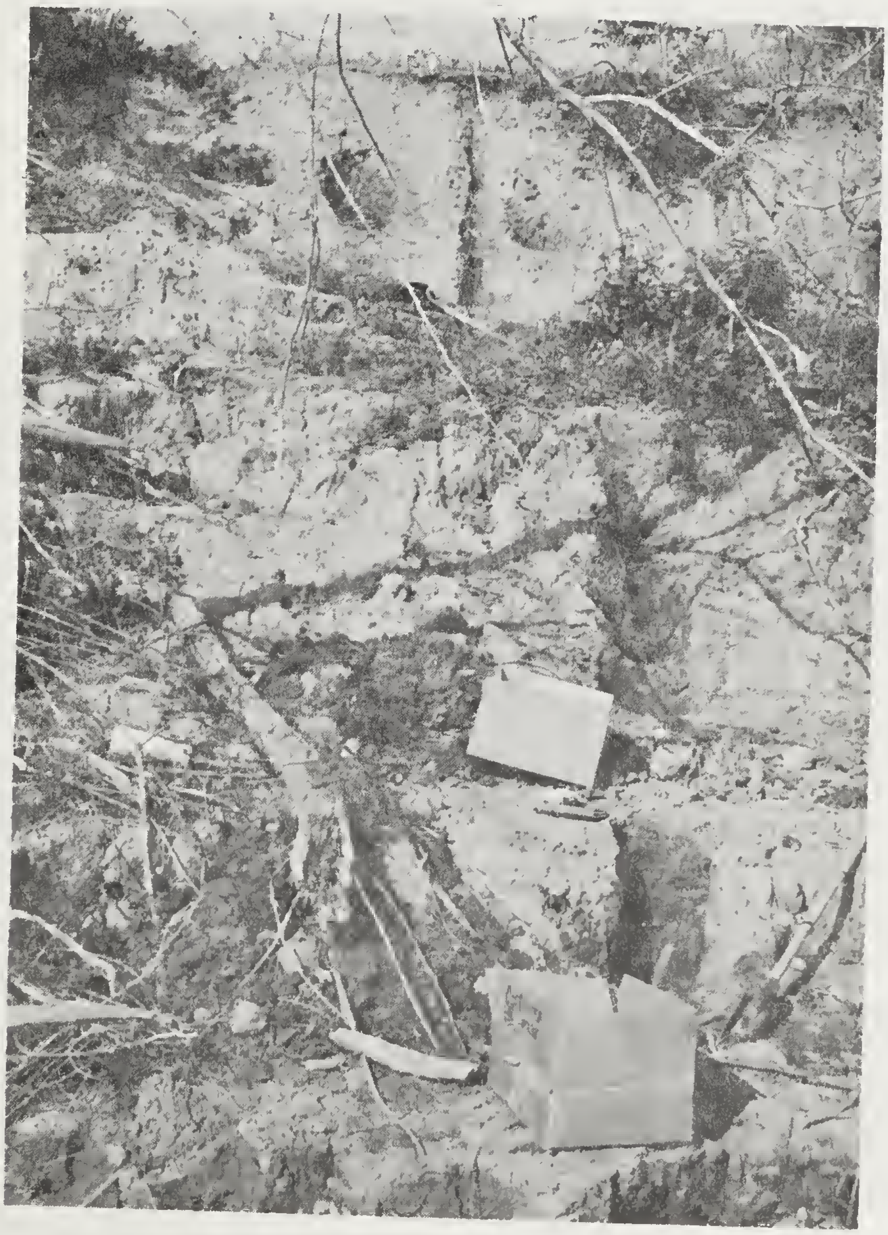
Figure B-1-7

J. & J. Schwab
Tract 1307 E



C

Bank area approximate to upstream boundary of tract at sample site. 24 May 1977



D

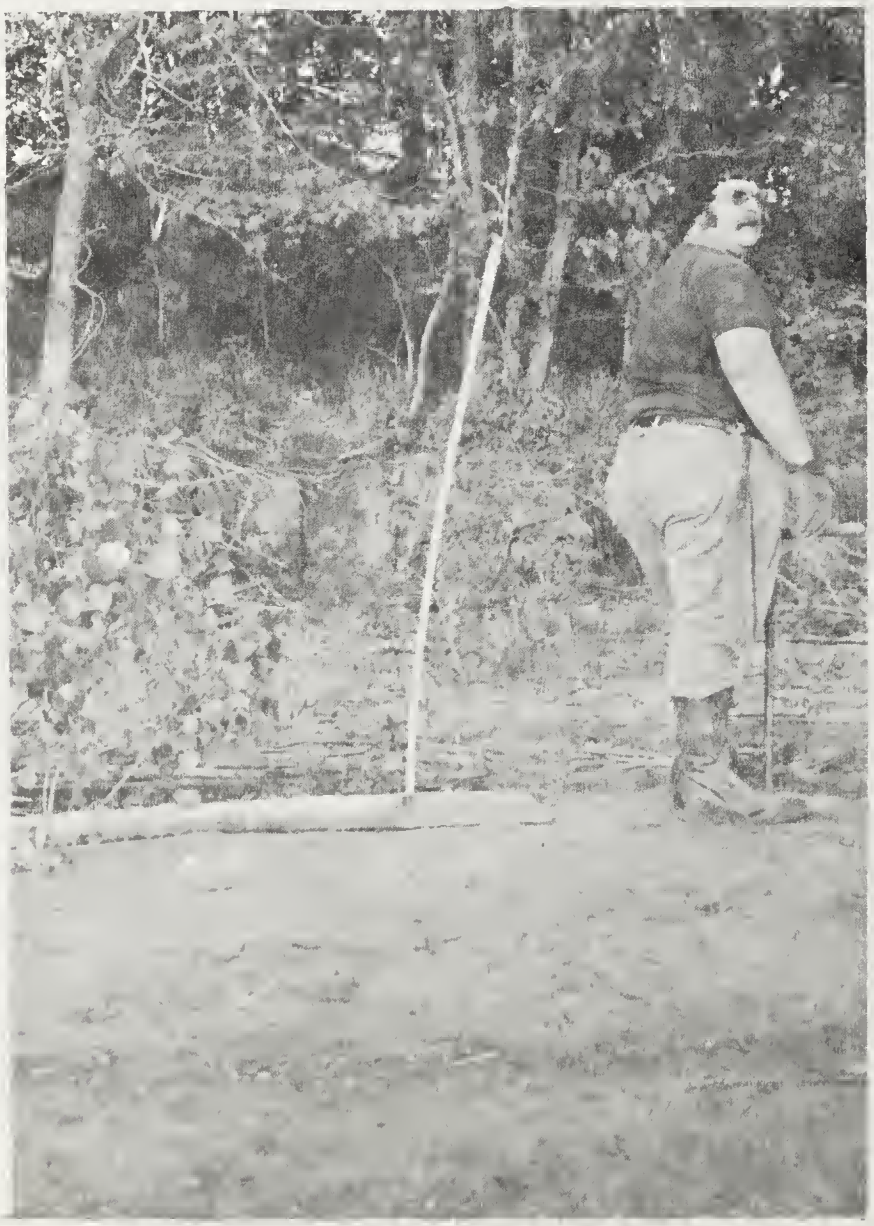
Bank area sample site. Note benching in slumpage derived debris. 12 May 1977

Figure B-1-7

B. Griffith
Tracts 1353 E - 1 & 2

A

Reach of bank and sample site. 24 May 1977



B

Bank and erosion scarp at sample site.
12 May 1977

Figure B-1-8

C

Reach of lower bank and slope looking upstream toward limit of tract. 12 May 1977

D

Reach of lower slope on tract along Three Mile Creek Ohio. 12 May 1977

Figure B-1-8

B. Cunningham
Tract 2102 E - 1 & 2

A

Reach of slope approximate to upstream limit of tract. Note low terrace in tributary valley. Tributary stream at far left. 24 May 1977

B

Vicinity of sampling site in central portion of property. Only high terrace present.
24 May 1977

Figure B-1-9

C

Downstream limit of property showing lower terrace.
High terrace located behind tree line.
24 May 1977

D

Looking upstream near limit of tract.
Unnamed tributary enters Ohio River at left.
10 May 1977

Figure B-1-9

B. Cunningham
Tract 2102.E - 1 & 2

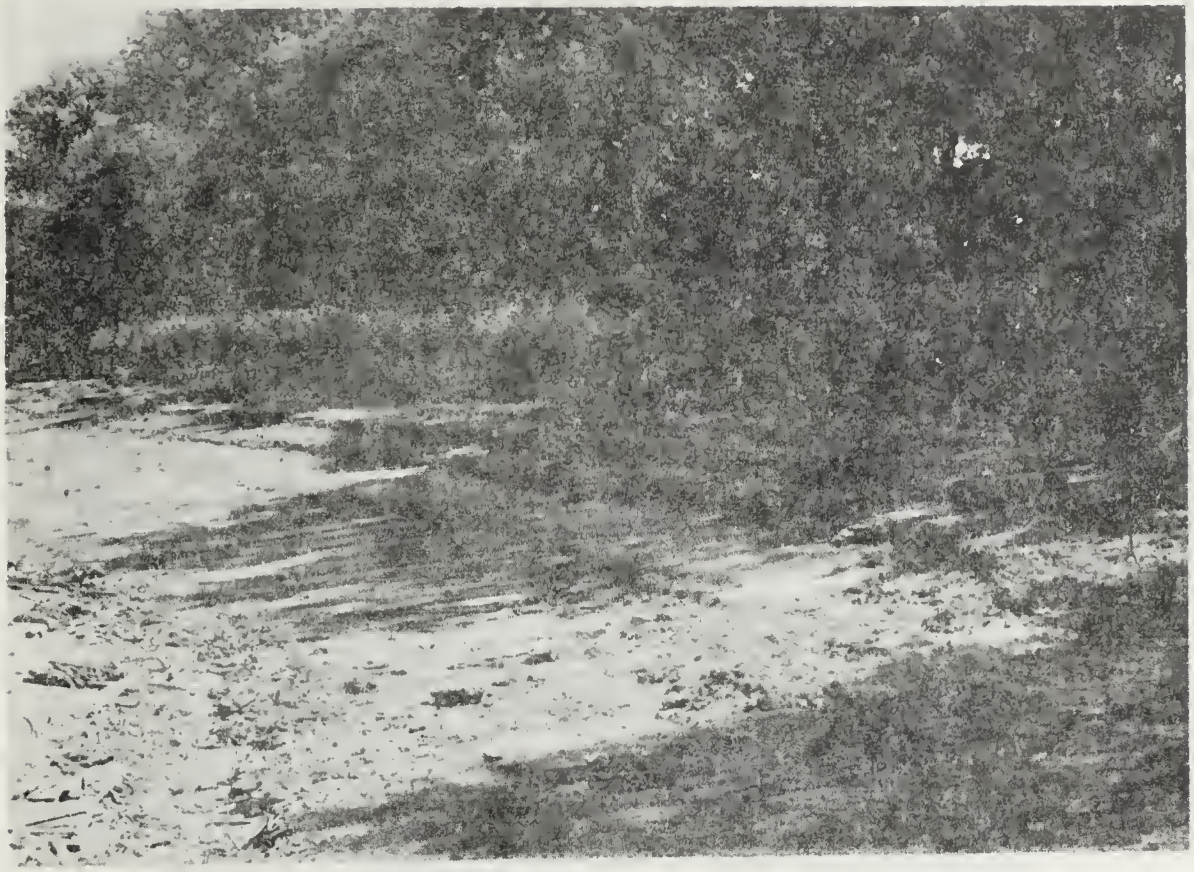
E

Lower terrace near upstream limit of tract.
10 May 1977

F

Beginning of high terrace frontage along Ohio River at right. Downstream limit of lower terrace at left. 10 May 1977

Figure B-1-9



G

Remnant of low terrace at downstream limit of tract. High terrace visible through trees. 12 May 1977

H

Looking upstream from near downstream limit of tract.
12 May 1977

Figure B-1-9

G. R. Wagner
Tract 410 E

A

Slide area and structure. 23 May 1977

B

Toe of slide and sample site. 9 May 1977

Figure B-1-10

G. R. Wagner
Tract 410 E

C

Structure on tract evidencing slide
related damage. 3 May 1977

D

Slide scarp at structure foundation. 3 May 1977

Figure B-1-10

H. Bynon
Tract 640 E

A

Looking downstream from the Bynon property along Rt. 166 alignment. Note bend in road at landslide area. 23 May 1977

B

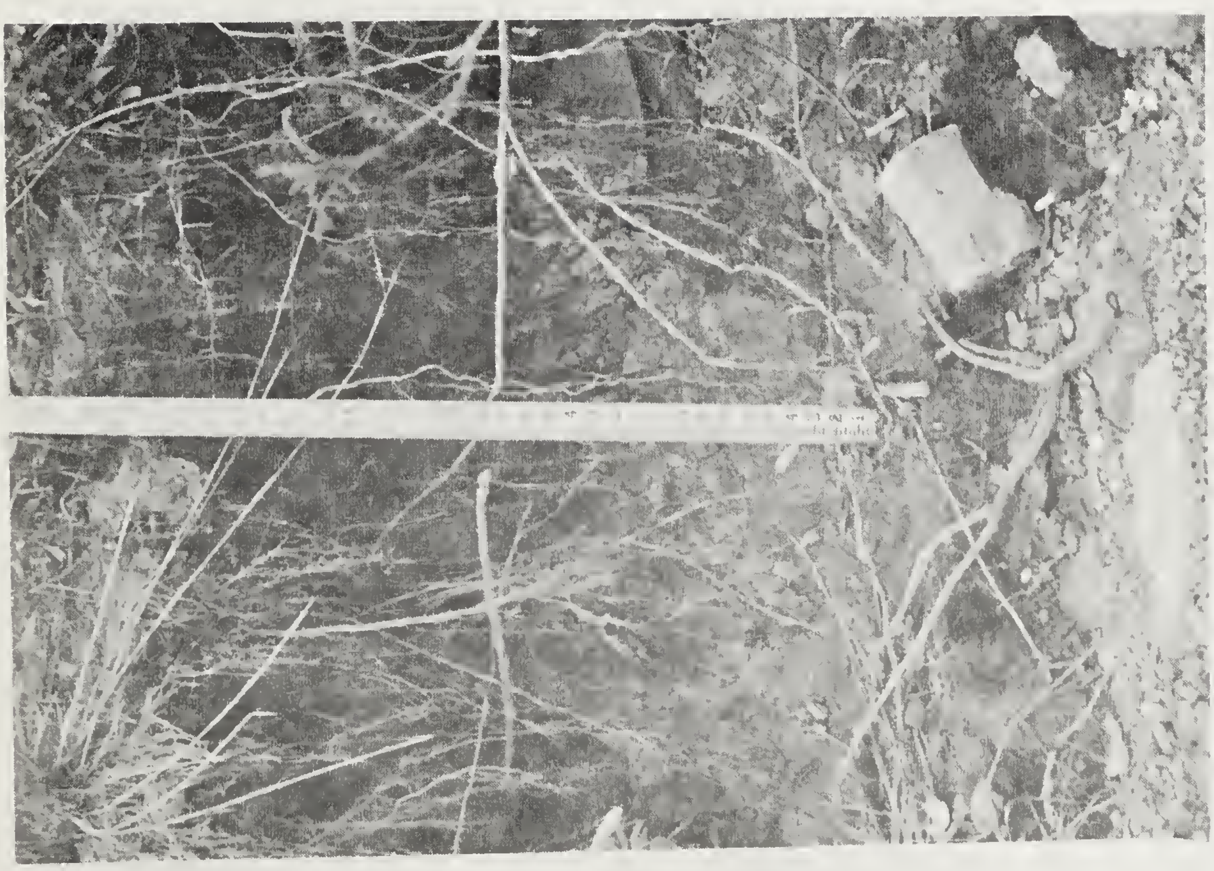
Looking at the Bynon property. Note rock out crop and landslide area with fallen trees at lower left of cliff. 23 May 1977

Figure B-1.11

H. Bynon
Tract 640 E

C

Slide area and structure. 5 May 1977



D

Exposure of cobbles in soil matrix at toe of slide.
5 May 1977

Figure B-1-11

D. C. Leatherbury
Tract 719 E

A

Confluence of Pond Run with the Ohio River. Note sediment plume. 23 May 1977

B

Bank area in central portion of tract. Pond Run located at left. 23 May 1977

Figure B-1-12

D. C. Leatherbury
Tract 719 E

C

Face of bank looking downstream from approximate the tract mid-point. 5 May 1977

D

Sample site. 5 May 1977

Figure B-1-12

E. W. Loesch
Tracts 1300 E - 1 & 2 & 1318 E

A

General view of Loesch property looking up river.
23 May 1977

B

Aerial view of mouth of unnamed tributary near upstream tract boundary. 23 May 1977

Figure B-1-13

C

Lower bank and grass-covered terrace.
2 May 1977

D

Toe of bank. Note buried limb of tree.
2 May 1977

Figure B-1-13

C. Eaton & G. Williams
Tract 2200 E

A

Approximate mid-point of property. Tree line follows Little Poison Creek. Past marks wave measurement station. 23 May 1977

B

Approximate upstream limit of property.
23 May 1977

Figure B-1-14

C. Eaton & G. Williams
Tract 2200 E

C

Sampling location
4 May 1977

D

Looking downstream from sampling location.
4 May 1977

Figure B-1-14

B. C. Glenn
Tracts 2215 E; 2218 E; 2410 E

A

General view of Glenn property looking upstream. 23 May 1977

B

Bank area showing recent erosion and apparent scour areas. 23 May 1977

Figure B-1-15

C

Apparent scour area in bank downstream of large inplace stump. 5 May 1977

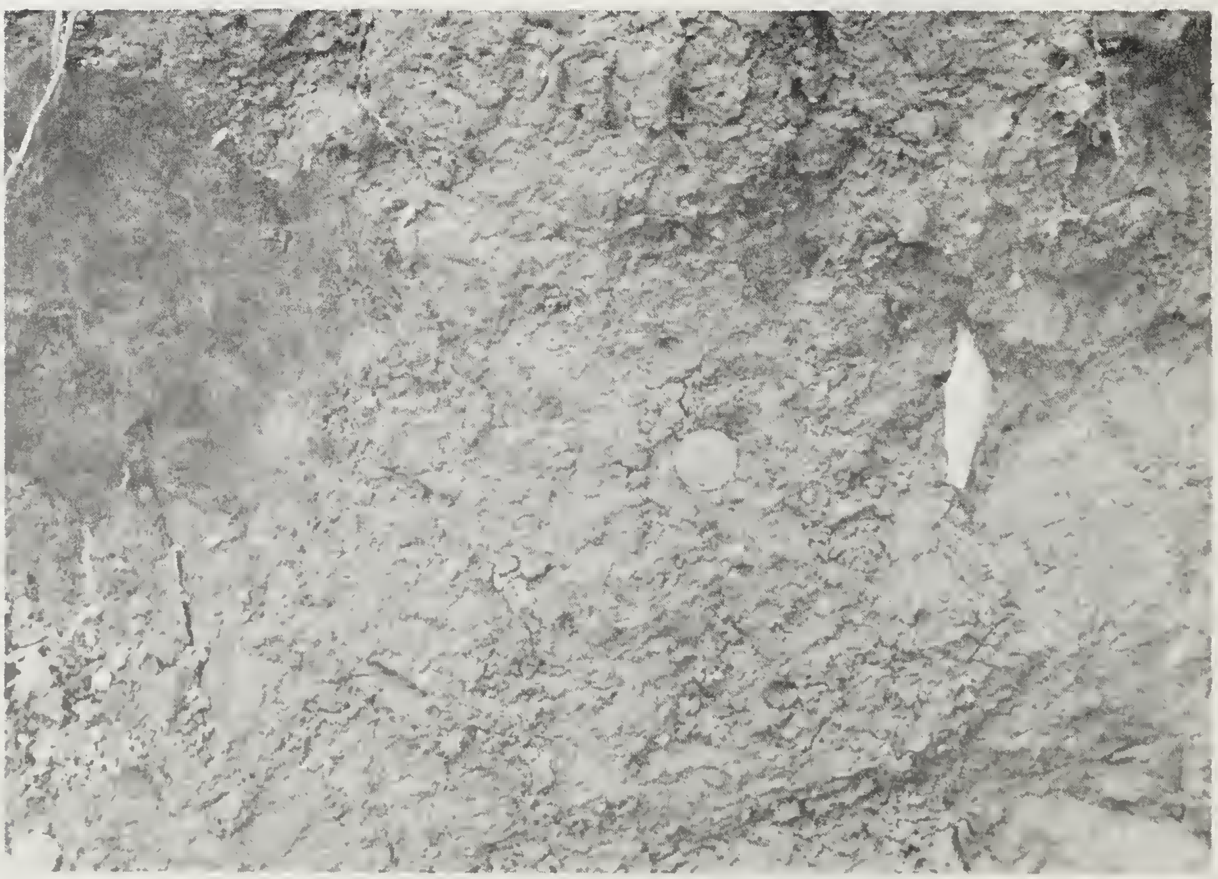
D

Tree with hawsers. 5 May 1977

Figure B-1-15

E

Sampling site located within the central portion of Glenn property. 5 May 1977

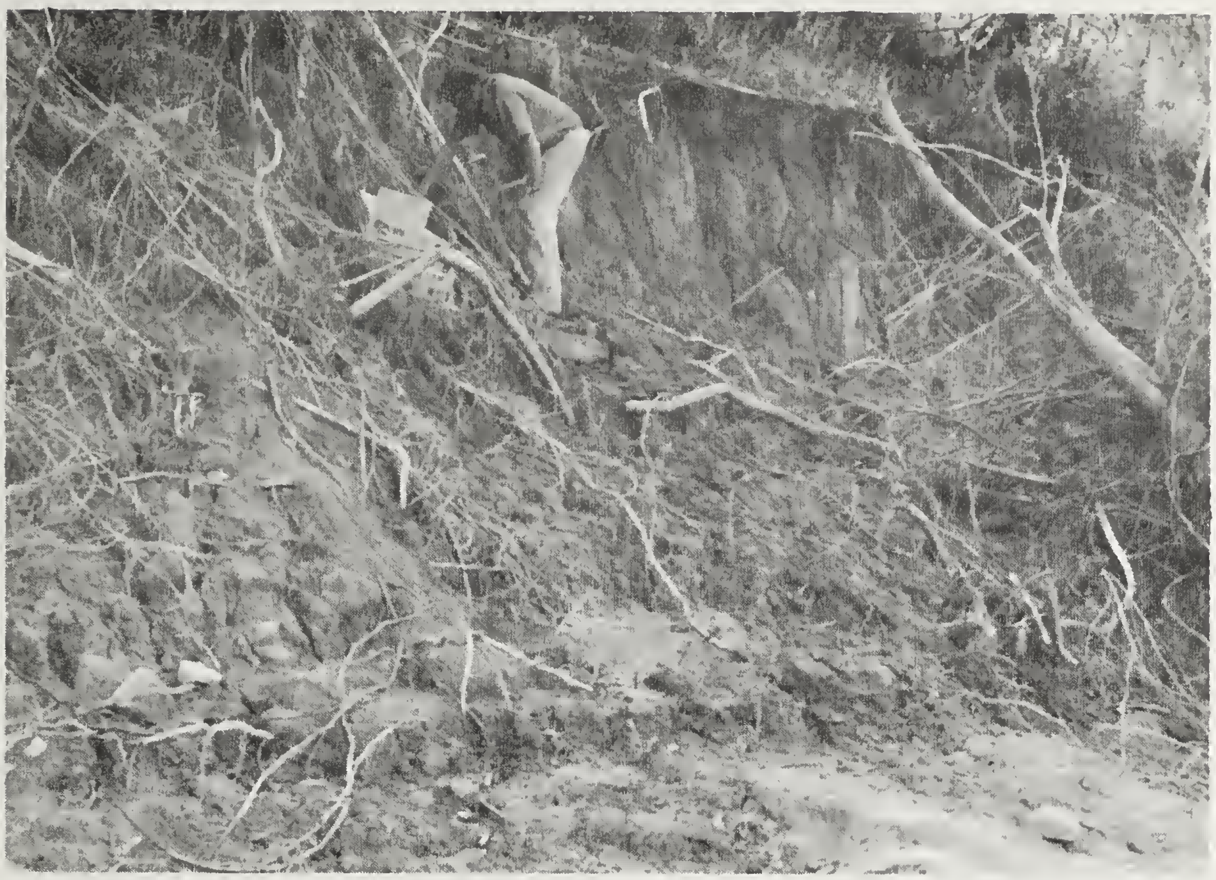


F

Worked flint in-situ at depth of 16.4' below top of bank near sampling site. Excavated bank at left.
5 May 1977

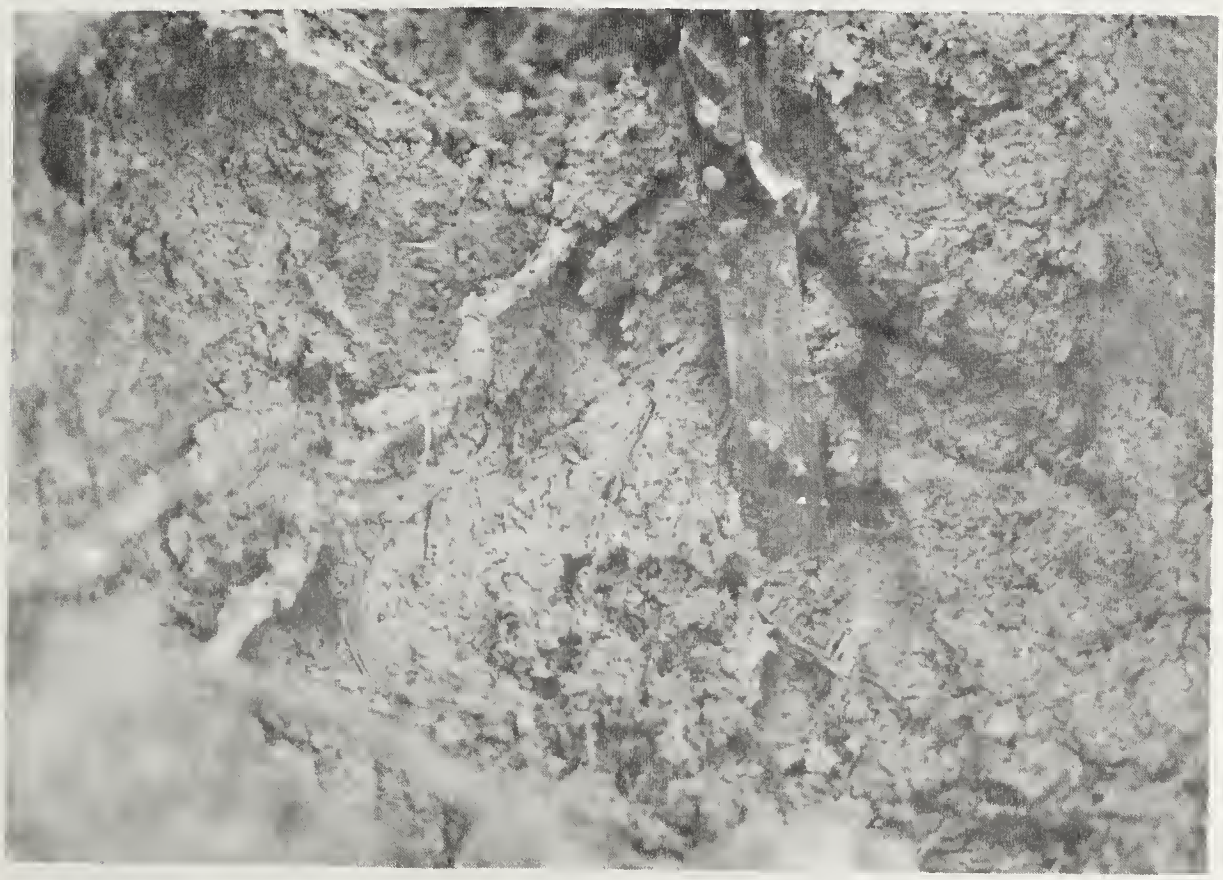
Figure B-1-15

B. C. Glenn
Tracts 2215 E; 2218 E; 2410 E



G

Sampling site within downstream portion of Glenn property. 5 May 1977

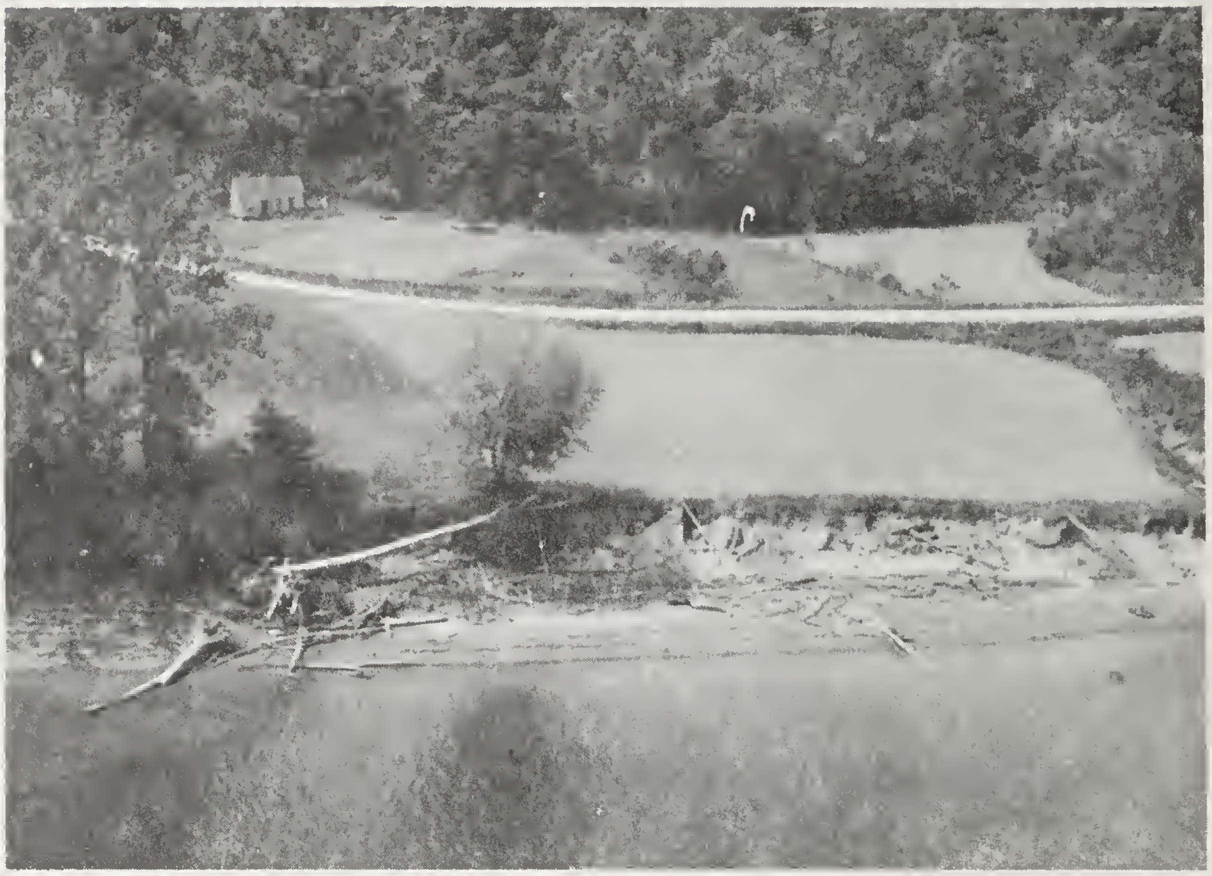


H

Soft gray organic soil at a depth of 17.6' below top of bank within area of sample site. 5 May 1977

Figure B-1-15

C & M Benner
Tract 3015 E



A

Bank area showing sample site. 23 May 1977

B

Bank area at sample site showing recent erosion and drift deposition. 3 May 1977

Figure B-1-16

C

Bank erosion within upstream area of tract. Note toppled trees. 3. May 1977

D

Bench area approximate to upstream boundary of tract. Note rock outcrop. 3 May 1977

Figure B-1-16

N. Purcell
Tracts 3229 E & 3238 E

A

Slide area looking east, showing scarps.
23 May 1977

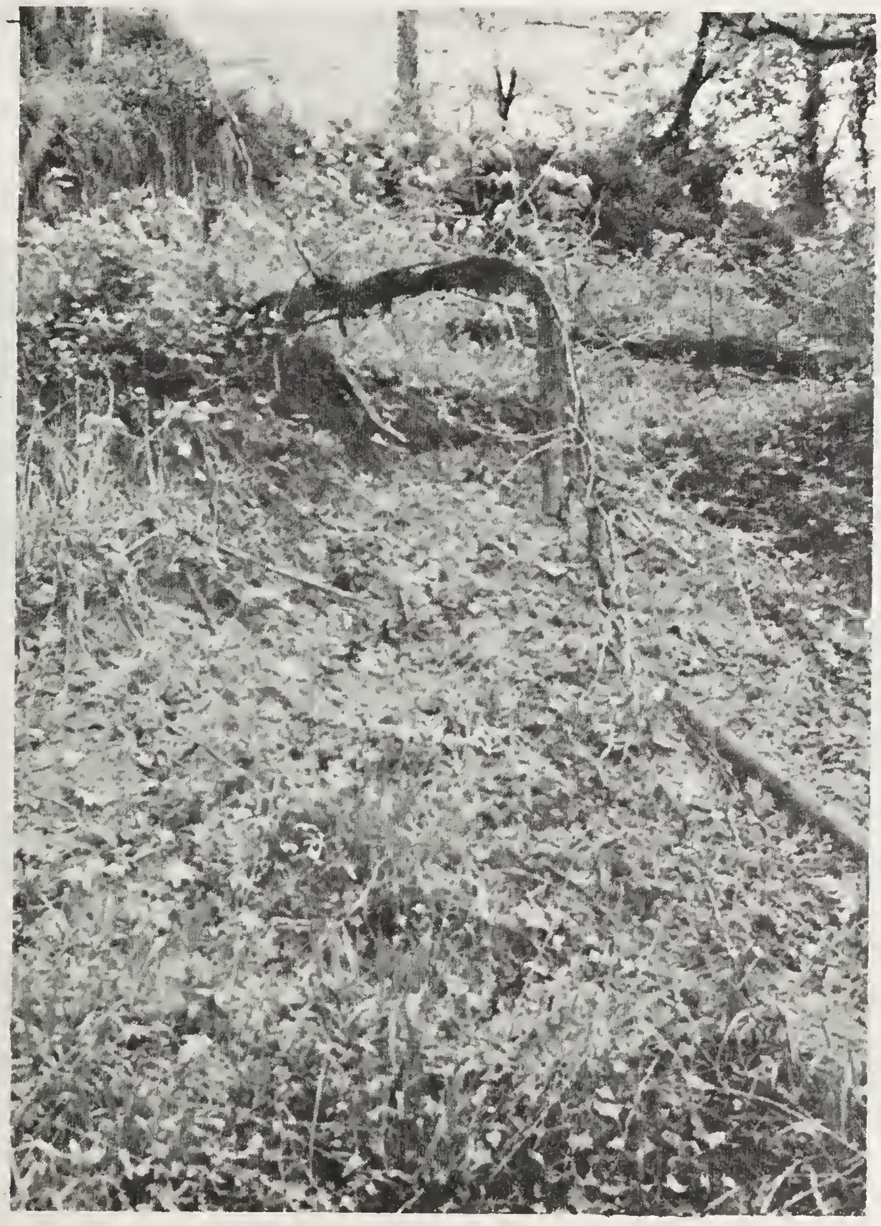
B

Slide area looking south, showing slumpage debris.
23 May 1977

Figure B-1-17

C

Slope failure exposed scarps and slumpage debris.
23 May 1977



D

Area of slide below trailer at
sample site. 4 May 1977

Figure B-1-17

R. Cox
Tract 3703 E

A

Reach of bank approximate to upstream boundary of tract showing bank and stone placed in drainway. 23 May 1977

B

Reach of bank and sample site
23 May 1977

C

Reach of bank showing recent erosion in upper slope area. 9 May 1977

D

Area evidencing recent erosion in toe of slope area. Note bench within upper bank areas. 9 May 1977

Figure B-1-18

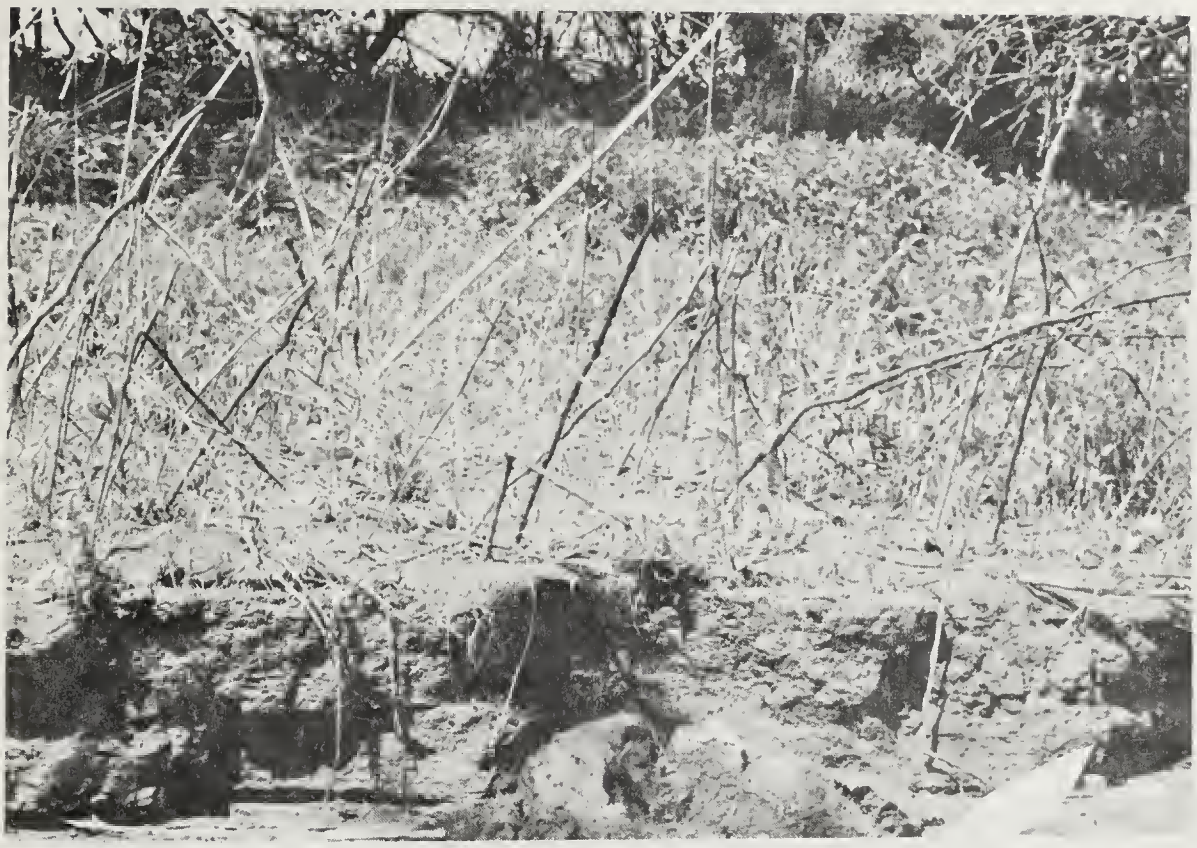
A

Sampling Site, 23 May 1977

B

Bank near sampling site with slumpage scarp in foreground.   29 April 1977

Figure B-1-19



C

Middle portion of bank with small erosion scarp.
29 April 1977

D

Lower portion of bank. Leaf fragments and multiple small erosion scarps are evident. 29 April 1977

Figure B-1-19

E. D. McGehee
Tract 5018

A

Sample site near upstream tract boundary. 23 May 1977

B

Benching of lower bank at sample site. 27 April 1977

Figure B-1-20

E. D. McGehee
Tract 5018

C

Logging and sampling near top of bank.
27 April 1977

D

Recent benching of bank area. 27 April 1977

Figure B-1-20

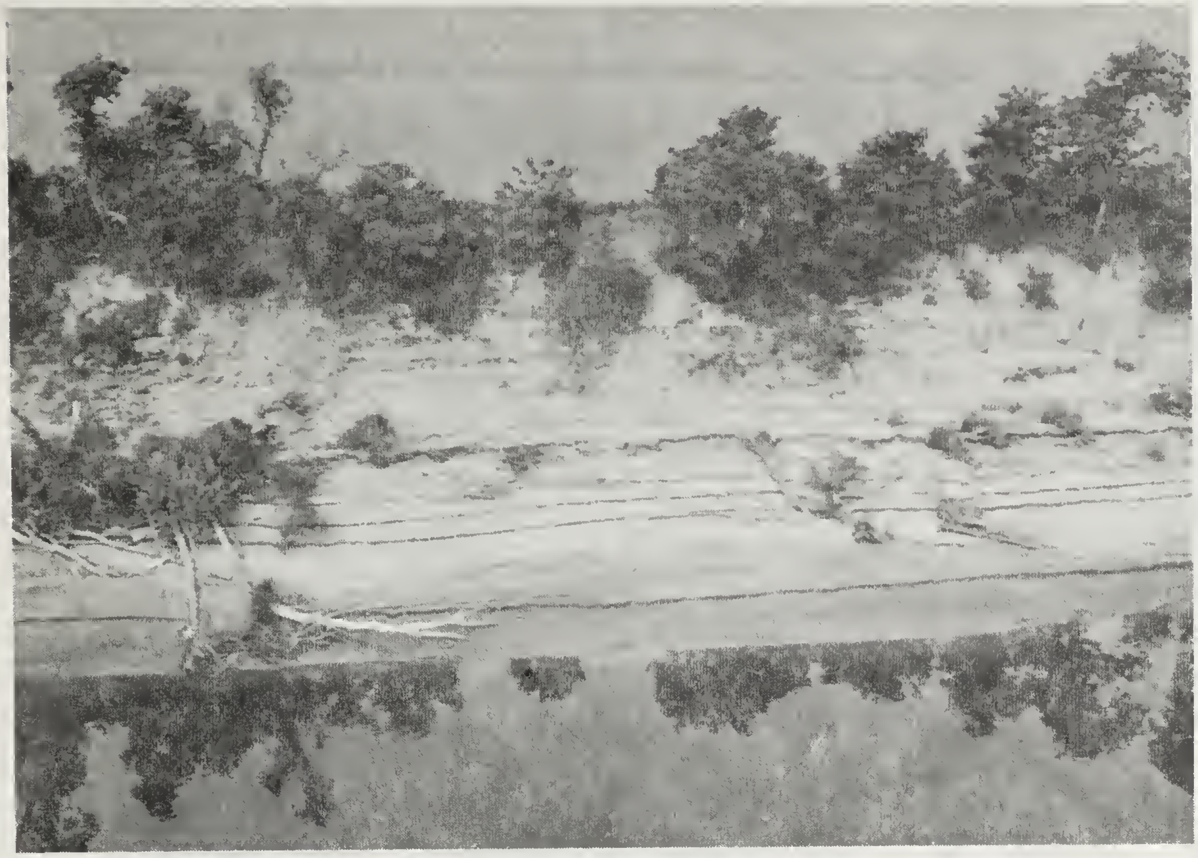
A

Looking downstream along J. H. McGehee Property.
23 May 1977

B

Area of transition from qranular to fine-grained bank materials. 23 May 1977

Figure B-1-21



C

Bank at sampling site. 23 May 1977

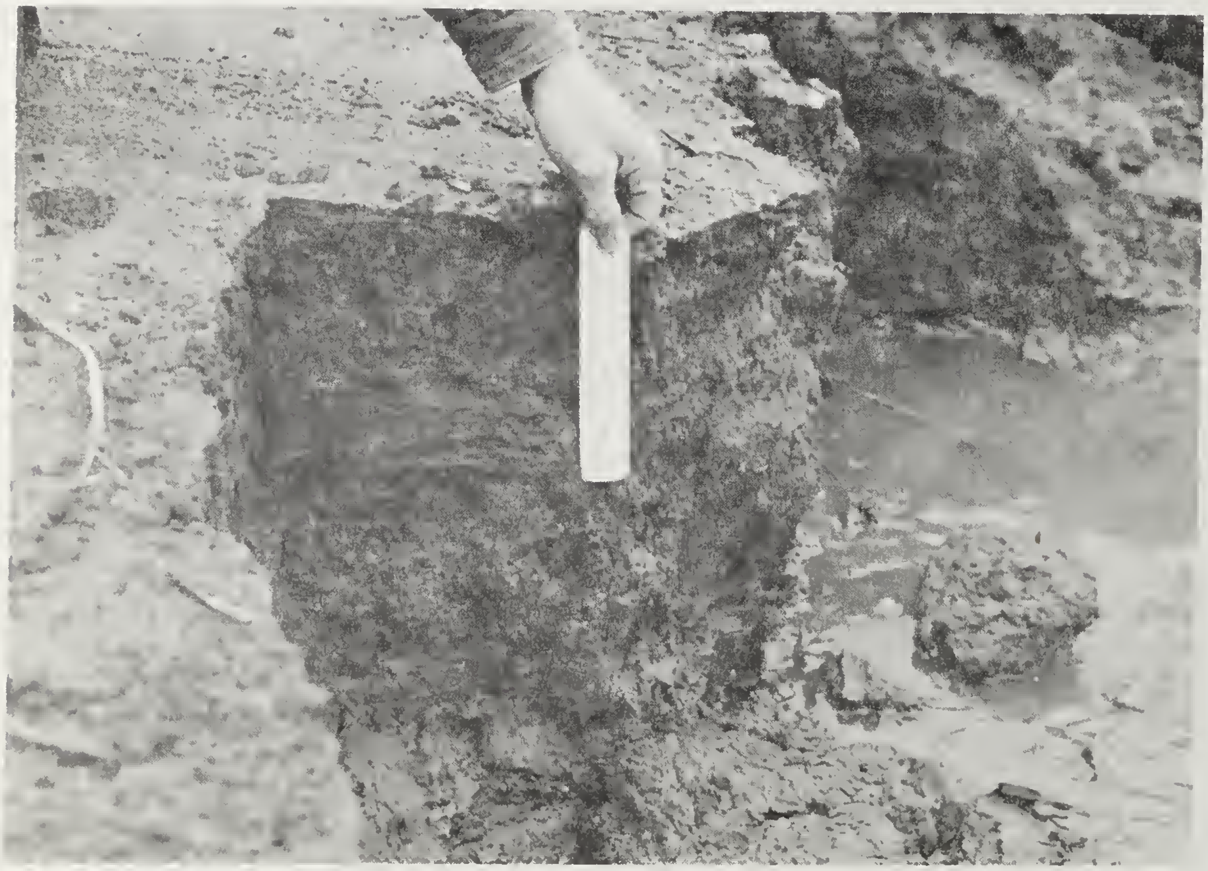
D

Narrow beach downstream of sampling site. Note dense gray silt exposed at lower right. 23 May 1977

Figure B-1-21

E

Fresh erosion scarp showing stratified sand, silt and gravel.   5 May 1977



F

Fresh erosion scarp evidencing stratification.
29 April 1977

G

Outcrop of dense gray silt overlain by iron-stained brown silt. 29 April 1977

H

Butt end of buried log in dense gray silt. Log was buried approximately 7,000 years B. P. 29 April 1977

Figure B-1-21

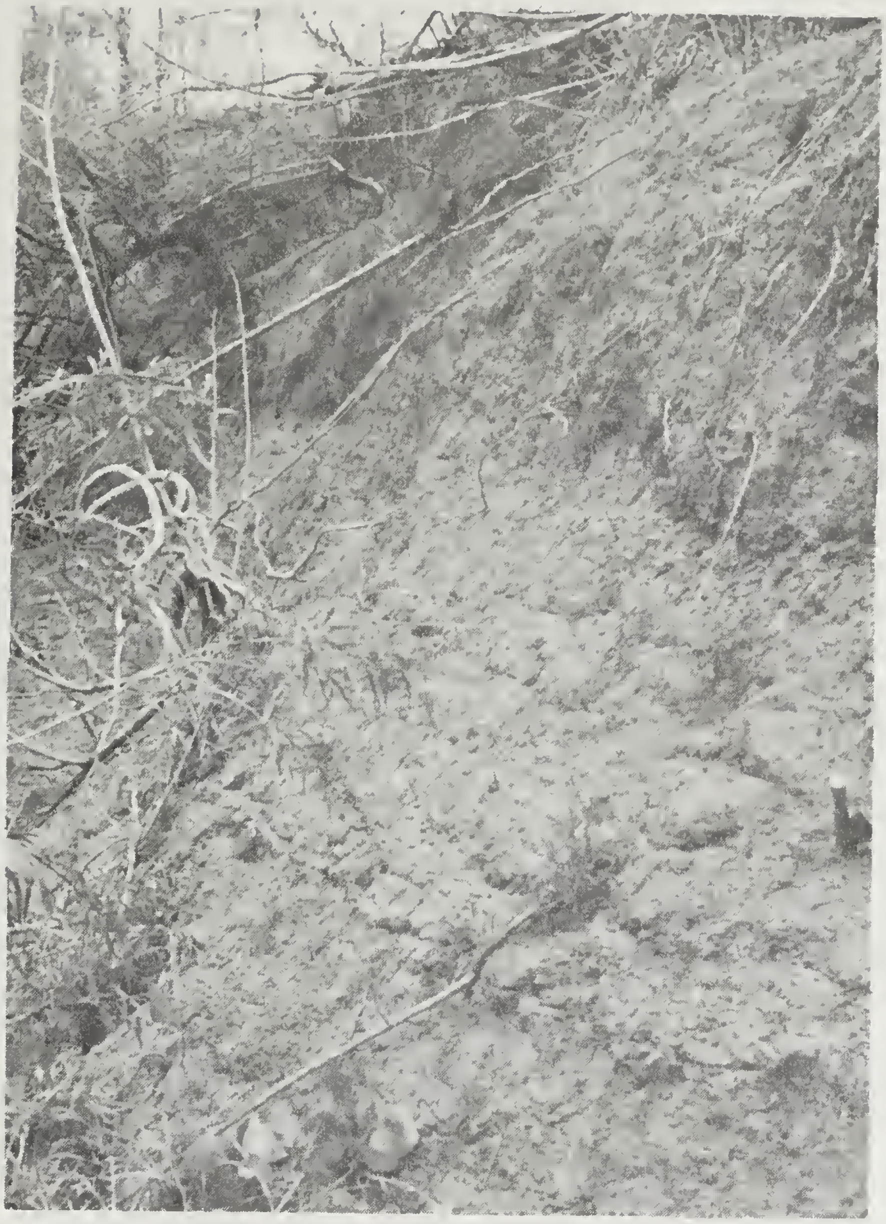
A

Dickenson Property and portions of adjacent tracts.
23 May 1977

B

Looking upstream along top of bank. Weeds at left mark sewage seepage which could be related to area of deepest bank erosion as located at right. 3 May 1977

Figure B-1-22



C

Bank area immediately downstream of sampling site. 3 May 1977

D

Layers of coal fragments within bank at paper and trowel levels (10.3' and 11.4' below top of bank, respectively) 3 May 1977

Figure B-1-22